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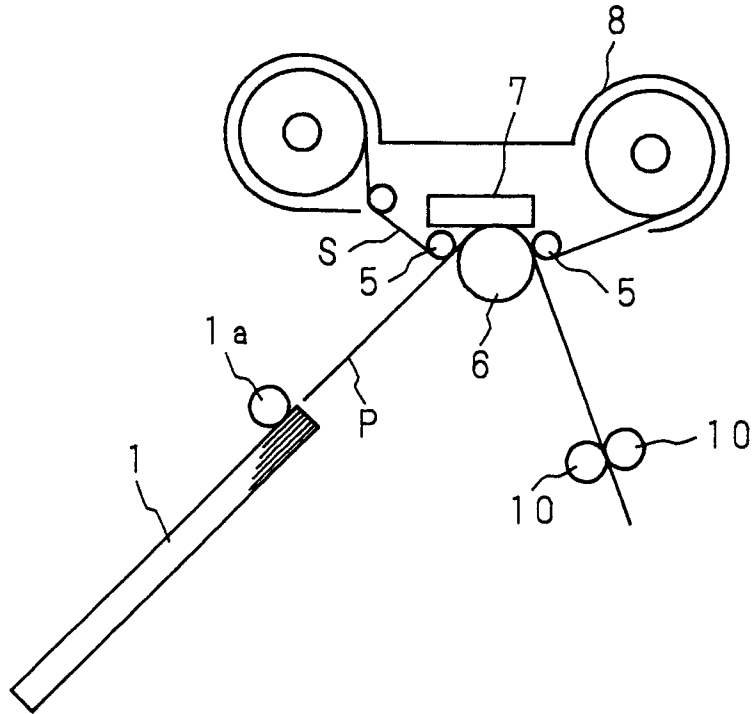
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Paper feed for printing apparatus.

A printing apparatus is composed in a constitution in which the conveying path P2 of printing paper P being from the confronting position of the platen roller 6 and thermal head 7 for composing the printing unit 3 to the paper discharge unit 2 is nearly linear, the capstan roller 4, pinch roller 5, and discharge rollers 10, 10 are disposed opposedly to the conveying path P2, and an intermediate position of the conveying path P2 is joined with the conveying path P1 being from the paper feed unit 1 to the

printing unit 3, and a paper feed port is disposed at the bottom of the paper cassette for composing the paper feed unit 1, so that the conveying path P1 being from the paper feed port to the printing unit 3 is shortened, and accordingly the paper conveying path is shortened, the constitution is simplified and downsized, while the precision of positioning of the printing paper and positioning of the printing head is enhanced, so that the printing quality may be improved.

Fig. 1
Prior Art



BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates mainly to a printing apparatus composed as a thermal transfer type using a thermal head.

Description of the Related Art

There is recently a mounting demand for apparatus for reproducing CRT and other display screens in color hard copies, and especially, as easy maintenance system, the apparatus for thermal transfer on paper by using color ink sheet having yellow, magenta and cyan colors is being requested.

For this type of printing apparatus, various structures have been hitherto proposed, and in a general structure, each printing paper separated from the paper feed unit is conveyed along the conveying path into the printing unit where the platen roller and thermal head are opposite to each other, and positioned, and a predetermined leader portion is taken out, and the printing processing is executed with respect to the printing paper while being conveyed, and is discharged in the paper discharge unit.

In the case of color printing, the printing paper is moved reciprocally plural times between the platen roller and thermal head by changing the color of ink sheet every time.

This type of printing apparatus is conventionally known in the structures as shown in Fig. 1 to Fig. 4.

Fig. 1 is, for example, a sectional view of a conventional printing apparatus disclosed in the Japanese Patent Application Laid-Open No. 63-249674 (1988). In the drawing, numeral 1 denotes a paper feed unit, 5 is a printing unit, and 10 is a discharge roller. The printing paper P supplied from the paper feed unit 1 is wound around the platen roller 6 by about a half circumference by pinch rollers 5, 5 and platen roller 6, and laid over the ink sheet S stored in an ink sheet cassette 8, and while moving the printing paper P and ink sheet S, thermal transfer is effected by the thermal head 7, and the paper is discharged through the discharge roller 10.

In color printing, on one same printing paper P, ink sheet S of plural colors are laid down sequentially to reproduce a color copy. In this case, after printing of one color, the platen roller 6 rotates in the reverse direction of printing operation to return the printing paper P to the print start position, and a different color from the first is printed on the same position of the printing paper P. This operation is repeated as many time as necessary, and

when printing is over, the printing paper P is discharged out of the apparatus from the discharge roller 10 through the platen roller 6.

In the conventional printing apparatus shown in Fig. 1, meanwhile, the platen roller 6 has a large diameter, and the paper feed unit 1 and paper discharge unit 2 are located at both sides of the platen roller 6, and separately in the upper and lower directions from the platen roller 6, and therefore the size of the printing apparatus is large, and since the printing paper P is wound around the platen roller 6 and becomes curly, which gives rise to troubles in conveyance, or color deviation is likely to occur in color printing.

To solve the problem of large size of the above printing apparatus, other printing apparatus were proposed, for example, as shown in Fig. 2 and Fig. 3.

Fig. 2 is, for example, a schematic side view of a conventional printing apparatus disclosed in the Japanese Patent Application Laid-Open No. 180839 (1987). In this printing apparatus, at one side of the platen roller 6 constructing the printing unit 3, a paper feed unit 1 and a paper discharge unit 2 are disposed, and the platen roller 6 is provided with a clamber 6a. In the conveying path from the paper feed unit 1 to the platen roller 6, conveying rollers 9, 9 and stationary paper guides Ga, Ga are disposed, while in the conveying path from the platen roller 6 to the discharge roller 10, there are movable paper guide Gg and stationary paper guide Gb.

As shown in Fig. 2 (a), the printing paper P supplied one by one by the paper feed roller 1a from the paper feed unit 1 is handed down to the conveying roller 9, and is conveyed to the opposing position of the thermal head 7 and platen roller 6 while being regulated by the stationary paper guide Ga, and with the front end portion thereof being clamped by the clamber 6a of the platen roller 6, it is taken up on the platen roller 6 along with the rotation of the platen roller 6. The thermal head 7 is lowered onto the platen roller 6 together with the ink sheet S, and is pressed against the surface of the printing paper P, so that thermal transfer is effected by the thermal head 7.

When printing is over, the platen roller 6 stops, and the thermal head 7 goes up. The movable paper guide Gg descends to abut against the circumference of the platen roller 6, thereby changing the conveying path to the discharge roller 10 side.

Finally, as shown in Fig. 2 (b), the platen roller 6 rotates in the reverse direction to that of the printing operation, and the printing paper P is sent out to the discharge roller 10 side along the movable paper guide Gg and stationary paper guide Gb, and is discharged out of the apparatus by the discharge roller 10.

On the other hand, Fig. 3 is, for example, a side view disclosed in the Japanese Patent Application Laid-Open No. 63-286361 (1988). In this printing apparatus, similarly, the paper feed unit 1 and paper discharge unit 2 are disposed in the upper and lower positions at one side of the printing unit 3, and the printing paper P supplied one by one from the paper feed unit 1 through the paper feed belt 1b is wound up on the circumference of the pinch roller 5 from the lower side of the platen roller 6, and is laid over on the ink sheet S on the platen roller 6, to perform thermal transfer by the thermal head 7. When printing is over, the movable paper guide Gg is caused to slide on the circumference of the platen roller 6, so as to discharge the printing paper P into the paper discharge unit 2 through the paper feed belt 1b.

In any case, meanwhile, in color printing, the printing paper P is rotated as many times as necessary in the state of being wound on the circumference of the platen roller 6 so as to contact with ink sheets S of different colors every time to make printing. Symbol F denotes a cooling fan of the thermal head 7.

In the conventional printing apparatus shown in Fig. 2 and Fig. 3, since the paper feed unit 1 and paper discharge unit 2 are disposed in upper and lower positions at one side of the printing unit 3, the size can be notably reduced, but since the diameter of the platen roller 6 is large, and downsizing is limited, and moreover in the structure of printing by winding the printing paper P on the platen roller 6, being same as in the printing apparatus shown in Fig. 1, the printing paper P is likely to be curly, and the number of parts increases because the conveying path for feeding the printing paper P and the conveying path for discharging are changed by operation of the movable paper guide Gg, and since the movable paper guide Gg is located near the platen roller 6, it is difficult to remove the paper in the event of paper jamming.

As the means for solving the problems in the conventional printing apparatus shown in Fig. 2 and Fig. 3, the printing apparatus as in Fig. 4 is known.

In Fig. 4, the paper feed unit and paper discharge unit (neither shown) are disposed at one side (the left side in Fig. 4) of the printing unit 3, and the platen roller 6 is made small in diameter, and capstan roller 4 and pinch roller 5 are disposed oppositely across the conveying path immediately before the platen roller 6, that is, at the side of paper feed unit 1 and paper discharge unit 2, and the conveying path connecting the capstan roller 4 and platen roller 6 are formed nearly in a linear form.

In such a conventional printing apparatus, although the size is further reduced by reducing the

diameter of the platen roller 6, it is necessary to determine the entire layout about the conveying path of the printing paper P, including the relation with the paper feed unit 1, paper discharge unit 2, and printing unit 3, but this point has not been considered sufficiently.

Incidentally, the paper feed unit 1, paper discharge unit 2 and printing unit 3 which is composed of the thermal head 7 and ink sheet cassette 8 and others in the conventional printing apparatus are structured as described below.

Fig. 5 is a schematic side view showing a practical constitution of the paper feed unit 1 in the conventional apparatus, and Fig. 6 is a perspective view of essential parts seen from the bottom side of the same, in which numeral 11 denotes a paper cassette for composing the paper feed unit 1. The paper cassette 11 comprises a casing 12 and a core member 13, and the casing 12 is open at the front side and in the front side bottom in the paper feeding direction of the printing paper P, and a top plate 12a is disposed in the upper portion, and the core member 13 is provided inside. Below the paper cassette 11, a paper feed roller 14 and a push-tip member 15 are disposed, and a stationary paper guide 16 is installed further ahead.

The core member 13 has separation pawls 13b, 13b for supporting the lower portion of the right and left corners at the front end side of the feeding direction of the printing paper P stored in the casing 12, and the right and left side walls of the rear end portion are pivoted on the side wall of the casing 12 by using a shaft 13c. The push-up member 15 and arm 14a of the paper feed roller 14 are coaxially pivoted by using a shaft 15a, and they are rotated in the direction of arrow around the shaft 15a by a drive unit not shown, while the paper feed roller 14 is rotated, and the push-up member 15 contacts with or departs from the contact piece 13d of the core member, and the paper feed roller 14, with or from the bottom of the printing paper P exposed in the lower side of the casing 12. As a result, the paper feed roller 14 is rotated about the shaft, and contacts with the lower side of the printing paper P with a predetermined pressure, and by the frictional force acting between them, the printing paper P at the lowest position is separated from the others, and is fed forward.

The operation of such paper feed unit 1 is explained below by reference to the explanatory view of Fig. 7.

Fig. 7 shows the paper feed state, in which the push-up member 15 is rotated about the shaft 15a and abuts against the contact piece 13d, and pushes and rotates the core member 13 until the upper surface of the printing paper P abuts against the top plate 12a about the shaft 13c, with the both sides of the front portion of the printing paper P

held in the separation pawl 13b, and stops in the state being thrust upward.

The arm 14a is also rotated in the same direction, and presses the paper feed roller 14, which is rotated and driven, to contact with the lower side of the printing paper P with a predetermined pressure. By the frictional force acting between the paper feed roller 14 and printing paper P, the printing paper P at the lowest position is separated from the other printing papers, and the front end portion slips out of the separation pawl 13b, and is guided by the stationary paper guide 16 to be fed into the printing unit 3.

The paper feed position of the printing paper P is moved from position D to position E as the number of sheets decreases.

In such a conventional paper feed unit 1, meanwhile, since the paper feed position moves from D to E depending on the number of sheets of the printing paper P, when the storage capacity of the printing paper P is increased, the interval of the stationary paper guides 16 is also increased accordingly, and the stationary paper guides 16 come to occupy a wide space.

Fig. 8 is, for example, a schematic plan view showing the positioning means of printing paper P for the printing unit 3 in the conventional printing apparatus disclosed in the Japanese Patent Application Laid-Open No. 1-290465 (1989), and Fig. 9 is its schematic side view. At one side of the opposing positions of platen roller 6 and thermal head 7, that is, at the opposite side of the layout position of the capstan roller 4 and pinch roller 5, stationary paper guides 17a, 17b are disposed oppositely above and beneath, and a conveying path for switchback is formed. The front end of the upper stationary paper guide 17a serves also as the guide of the ink sheet cassette 8, and a hole Gc is provided in the center of the rear end portion, and a front end sensor SE is disposed here, and a reflector 18 is disposed in the opposing lower stationary paper guide 17b. When the printing paper P is detected by the front end sensor SE, the rotation of the capstan roller 4 is stopped, and the printing paper P is positioned, that is, the beginning portion is taken out.

The operation of such positioning means is described below by reference to the explanatory view shown in Fig. 10. When feeding paper, as shown in Fig. 9, the thermal head 7 is waiting aside above the platen roller 6, and the printing paper P is conveyed in the arrow direction by the pinch roller 5 and capstan roller 4, and is led in between the stationary paper guides 17a, 17b. When the front end of the printing paper P comes to the sensing point of the front end sensor SE, driving of the capstan roller 4 stops, thereby finishing the leading out action.

As shown in Fig. 10, the thermal head 7 descends until the ink sheet S contacts tightly with the printing paper P, and the platen roller 6 and capstan roller 4 are rotated and driven reversely, and the printing paper P is switched back in the arrow direction, and the thermal head 7 is heated to make printing.

In color printing, after printing one color in the step shown in Fig. 10, the printing paper P is switched back and returned to the position shown in Fig. 9, and the ink sheet S of the next color is detected, and thereafter the operation shown in Fig. 9 and Fig. 10 is repeated as many times as required.

In such conventional positioning means, in the case where the beginning of the printing paper P is detected, since the distance between the front end sensor SE of the printing paper P and the heat generation unit 7a of the thermal head 7 is long, the printing paper P sags on the way, and slipping occurs between the printing paper P and capstan roller 4, pinch roller 5, and the printing paper P may run obliquely, and the positioning precision is poor, the print start position is likely to be dislocated, and color deviation occurs in color printing.

Fig. 11 is, for example, a schematic plan view showing a thermal head and its positioning means in a conventional printing apparatus disclosed in the Japanese Patent Application Laid-Open No. 63-132065 (1988), and Fig. 12 is its schematic side view. The thermal head 7 is shaped like a rod, comprising a linear heating portion 7a in the middle of the lower side opposite to the platen roller 6, and radiation fin 7b in the upper side, and the middle portion of the holding members 21, 21 disposed at both ends in the longitudinal direction is pivoted in the middle of the support arms 22a, 22a of the pressing member 22 through the shafts 21a, 21a.

The pressing member 22 has a pressing plate 22b opposing to the thermal head 7 in a straddling manner over the upper sides of the front end portions of support arms 22a, 22a in an L-shape in side view, and plural contact springs 23 are disposed between the pressing plate 22b and the upper surface of the thermal head 7, accumulating a dilating force, and each base end portion is pivoted on the shaft 22c, and drooping pieces 22d disposed at both ends of the front end portion of the support arms 22a, 22a are provided with notches 22e to be engaged with the shaft 6b of the platen roller 6, while stopper pieces 22f, 22f are projected at the positions confronting the rear end portions 21c of the support members 21, 21.

The operation of such thermal head 7 is explained referring to the explanatory view of Fig. 13.

Fig. 13(a) shows a state of the thermal head 7 in the waiting position, and in this state, by the

dilating force of the contact spring 23, the holding member 21 and support arm 22a of pressing member 22 are thrust in the mutually departing directions, and the rear end portion 21c of the holding member 21 is abutting against the stopper piece 22c.

When pressing the thermal head 7 to the platen roller 6, by the drive unit not shown, the pressing member 22 is rotated in the arrow direction shown in Fig. 13(b) about the shaft 22c together with the holding member 21, and the thermal head 7 abuts against the circumference of the platen roller 6, and the notches 22e formed in the support arm 22a of the pressing member 22 are engaged with the shaft 6b of the platen roller 6, thereby relatively positioning the thermal head 7 and platen roller 6.

From the state in Fig. 13(b), when the pressing member 22 is further rotated, since the thermal head 7 is contacting with the platen roller 6, the contact spring 23 is compressed, and the thermal head 7 is pressed by the platen roller 6 to be in the state shown in Fig. 12, thereby pressing the thermal head 7 to the platen roller 6 and positioning the heating portion 7a of the thermal head, and in this state the heating unit 7a is heated to make printing.

In such conventional thermal head 7 and its holding member 21, looseness is likely to occur between the notch 22e and shaft 6b for relatively positioning the thermal head 7 and platen roller 6, and color deviation occurs, but, to the contrary, when the fitting of the notch 22e and shaft 6b is too tightly, the contact pressure of the heating portion 7a in the thermal head 7 changes, and uneven density occurs, and the load of the platen roller 6 on the shaft 6b increases to cause driving loss, and the rotating speed of the platen roller 6 varies, and color deviation occurs similarly.

Fig. 14 is, for example, a schematic plan view showing driving unit and cooling means of a thermal head 7 in a conventional printing apparatus disclosed in the Japanese Utility Model Application Laid-Open No. 63-37243 (1988), and Fig. 15 is its schematic side view, in which another shaft 24 is disposed parallel to a shaft 22c for pivoting the base end portion of a support arm 22a at the pressing member 22, the shaft 24 being provided with cam 24a and gear 24b to slide and contact with the shaft 22c, and this gear 24b is coupled with a motor M1 through reduction gear 24c and worm gear 24d.

As the cooling means of the thermal head 7, a radiation fin 7b is disposed on the upper surface of the thermal head 7, and a cooling fan 25 is installed above the thermal head 7. The radiation fin 7b is dense in the interval thereof in the middle of the longitudinal direction corresponding to the dis-

tribution of the accumulated heat temperature of the thermal head 7 shown in Fig. 16, and loose in the interval thereof gradually as going toward the both ends therefrom, so as to cool corresponding to the accumulated heat distribution of the thermal head 7.

The cooling fan 25 is installed so as to blow air always down toward the thermal head 7 side as indicated by arrow shown in Fig. 15. Numeral 26 is a stopper, disposed at the upper side of the both end portions of the thermal head 7, and is linked to the support arm 22a of the pressing member 22, thereby regulating the mutual maximum spacing distance.

The other parts are identified with the same reference numbers as the corresponding parts in the conventional apparatus shown in Fig. 11 and Fig. 12.

The operation of the thermal head 7 is explained below by reference to the explanatory view shown in Fig. 17. Fig. 17(a) shows the waiting state, in which air is blown to the thermal head 7 by the cooling fan 25.

When pressing the thermal head 7 to the platen roller 6, first the motor M1 shown in Fig. 15 is rotated to turn the shaft 24 and drive the cam 24a, and the pressing member 22 and the thermal head 7 are rotated together in the direction of the arrow in broken line as shown in Fig. 17(a), then the thermal head 7 is fitted to the circumference of the platen roller 6 as shown in Fig. 15.

From the state shown in Fig. 15, the cam 24a is further rotated, and the contact spring 23 is compressed by the pressing member 22, and the thermal head 7 is pressed against the platen roller 6 as shown in Fig. 17(b) to make printing. At this time, the heat from the thermal head 7 is released through the radiation fin 7b, while air is blown in from the cooling fan 25 to cool.

The cooling means, incidentally, may comprises a cooling fan F as shown in Fig. 3.

In such conventional cooling means, the surface area of the radiation fin 7b is small, and a sufficient cooling effect is not obtained for the amount of heat generated by the thermal head 7, and since the cooling fan 25 or F is installed above the thermal head 7, even while the thermal head 7 is at waiting position, the position of installation of the cooling fan 25 or F is high in order to avoid mutual interference, and to the contrary, the distance from the thermal head 7 is long while printing, resulting in the cooling effect being smaller, and moreover the overall height of the printing apparatus becoming high, and when the heat is accumulated more in the thermal head 7, the ink of the ink sheet S sublimes in excess, and is transferred on the printing paper P, and hence the printing density varies with the passing of the time.

Fig. 18 is, for example, a perspective view of an ink sheet cassette 8 in a conventional printing apparatus disclosed in the Japanese Patent Application Laid-Open No. 63-47179 (1988). The ink sheet cassette 8 comprises a cylindrical feed side bobbin 31 winding an unused ink sheet S, and a cylindrical takeup side bobbin 32 for taking up the used ink sheet S, which are incorporated inside thereof in parallel to each other with each one end exposed outside.

Such ink sheet cassette 8 is stored in a storage magazine 33, and is inserted into or removed from the printing apparatus in a state of coupling the bobbins 31, 32 with a reel device 34. The reel device 34 is designed to take up the ink sheet S by rotating the bobbin 32 about its axial center line by means of a drive unit not shown.

In such conventional ink sheet cassette 8, when detaching or attaching it, the storage magazine 33 must be drawn out to the front panel of the printing apparatus by sliding in the arrow direction, and the ink sheet cassette 8 is taken out by putting a hand into the storage magazine 33, and the ink sheet cassette 8 must be put in, and it takes time to detach and attach the ink sheet cassette 8, and the slide mechanism is needed for inserting the storage magazine 33 into the printing apparatus or removing it therefrom, and the number of parts of the printing apparatus increases on the whole.

Fig. 19 is, for example, a perspective view of a drive system corresponding to the reel device 34 (see Fig. 18) and discharge roller 10 (see Fig. 1 and Fig. 2) in a conventional printing apparatus disclosed in the Japanese Patent Application No. 63-122572 (1988). In the drawing, numeral 41 is a gear linking with a reel device 34, and 42 is a gear linking with a discharge roller 10 of printing paper P. The both gears 41, 42 are disposed by keeping their axial center lines parallel and deviating by a predetermined interval in the axial center line direction, and in the middle of the both gears 41, 42 is disposed a shaft 44 of a square section formed integrally with the shaft of a worm wheel 43, and a relay gear 45 is put on the shaft 44 so as to slide thereon through a compression spring 44a.

On the side of the relay gear 45, that is, on the opposite side of the contact side of the compression spring 44a, one fork-shaped end of a changeover lever 46 having the middle portion pivoted by a shaft 46a is located oppositely across the shaft 44. At the other end of this changeover lever 46, an engaging groove 46b is provided, and this engaging groove 46b is engaged with a pin 47a projecting a little close to the peripheral side of the worm wheel 47. The worm wheels 43, 47 are linked with respective motors M2, M3 through worm gears 48, 49.

Such drive system is explained below by refer-

ence to the explanatory views of operation shown in Fig. 20 and Fig. 21. Fig. 20 shows the engaged state of the relay gear 45 and gear 41 linked with the reel device 34 of the ink sheet cassette 8, while the relay gear 45 and the gear 42 linked with the discharge roller 10 are not engaged.

The driving force of the motor M2 is transmitted only to the gear 41 through worm gear 48, worm wheel 43, shaft 44 and relay gear 45, and the reel device 34 is driven. Next, when the motor M3 rotates in a predetermined direction, the worm gear 49 and worm wheel 47 rotate, and the changeover lever 46 rotates about the shaft 46a through a pin 47a, and the relay gear 45 oscillates in the arrow direction against the dilating force of the compression spring 44a, so that the relay gear 45 is released from the gear 41 and is engaged with the gear 42 as shown in Fig. 21.

In this state, the driving force of the motor M2 is transmitted only to the gear 42, and the discharge roller 10 is driven, and the reel device 34 stops. When the motor M3 rotates in the reverse direction, the relay gear 45 is released from the gear 42, and is engaged with the gear 41 to return to the state shown in Fig. 20.

Thus, in the conventional drive system as above-mentioned, the motor M3 is necessary separately for changing over the transmission of driving force, and the number of motors increases, resulting in the mechanism being complicated, the reliability being lowered, and the entire apparatus becoming larger in size.

SUMMARY OF THE INVENTION

It is hence a primary object of the invention, devised in the light of the background stated above, to present a printing apparatus which is reduced in the overall size of apparatus, shorter and linear in the conveying path of the printing paper so as to prevent conveying troubles of the printing paper, and heightened in the positioning precision of the printing paper and thermal head to the platen roller so as to prevent color deviation and thereby obtain printing of high quality.

A printing apparatus is composed in a constitution in which the conveying path of printing paper being from the confronting position of the platen roller and thermal head for composing the printing unit to the paper discharge unit is nearly linear, the capstan roller, pinch roller, and discharge rollers are disposed oppositely to the conveying path, and an intermediate position of the conveying path is joined with the conveying path being from the paper feed unit to the printing unit, and a paper feed port is disposed at the bottom of the paper cassette for composing the paper feed unit, so that the conveying path being from the paper feed port

to the printing unit is shortened, and accordingly the paper conveying path is shortened, the constitution is simplified and downsized, while the precision of positioning of the printing paper and positioning of the printing head is enhanced, so that the printing quality may be improved.

The above and further objects and features of the invention will more fully be apparent from the following detailed description with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side view showing a conventional printing apparatus,

Fig. 2 is a schematic side view showing other conventional printing apparatus,

Fig. 3 is a schematic side view showing a different conventional printing apparatus,

Fig. 4 is a schematic side view showing a further different conventional printing apparatus,

Fig. 5 is a schematic side view showing a practical structure of paper feed unit in a conventional printing apparatus,

Fig. 6 is a perspective view of essential parts seeing the paper feed unit in Fig. 5 from the bottom side,

Fig. 7 an explanatory view of an operation of the paper feed unit in Fig. 5,

Fig. 8 is a schematic plan view showing a positioning sensor for printing paper in a conventional printing apparatus,

Fig. 9 is its schematic side view,

Fig. 10 is an explanatory view of an operation showing the positioning operation of the printing paper,

Fig. 11 is a schematic plan view showing a thermal head and its holding structure in a conventional printing apparatus,

Fig. 12 is its side view,

Fig. 13 is an explanatory view of an operation of the thermal head shown in Fig. 11 and Fig. 12,

Fig. 14 is a schematic plan view showing a drive unit of thermal head and its cooling means in a conventional printing apparatus,

Fig. 15 is its schematic side view,

Fig. 16 is an accumulated heat distribution drawing of a thermal head,

Fig. 17 is an explanatory view of an operation showing the relation between the thermal head operation and cooling means,

Fig. 18 is a perspective view of an ink sheet cassette in a conventional printing apparatus,

Fig. 19 is a perspective view showing a drive system of reel device and discharge roller in a conventional printing apparatus,

Fig. 20 is an explanatory view of an operation of the drive system shown in Fig. 19,

Fig. 21 is an explanatory view of an operation of the drive system shown in Fig. 19,

Fig. 22 is a schematic side view of a printing apparatus of the invention,

Fig. 23 is a perspective view of its essential parts,

Fig. 24 is a schematic side view showing a practical structure of a conveying path of printing paper in a printing apparatus of the invention,

Fig. 25 is an explanatory drawing showing the conveying passage of the printing paper conveyed in the conveying path shown in Fig. 24,

Fig. 26 is a schematic side view showing other example of conveying path,

Fig. 27 is a schematic side view showing a different example of conveying path of printing paper,

Fig. 28 is an enlarged perspective view of essential parts of the conveying path shown in Fig. 27,

Fig. 29 is an explanatory view of an operation of a movable paper guide shown in Fig. 27,

Fig. 30 is an explanatory view of an operation of a movable paper guide shown in Fig. 27,

Fig. 31 is an explanatory view of an operation of a movable paper guide shown in Fig. 27,

Fig. 32 is a perspective view showing other example of movable paper guide,

Fig. 33 is a schematic side view showing a practical structure of a paper feed unit in a printing apparatus of the invention,

Fig. 34 is its explanatory view of an operation,

Fig. 35 is a schematic side view showing a capstan roller which is a conveying roller disposed in the conveying path,

Fig. 36 is a schematic plan view of the same capstan roller,

Fig. 37 is a schematic plan view showing other example of capstan roller,

Fig. 38 is a schematic side view showing a further different example of capstan roller,

Fig. 39 is a schematic side view showing a further different example of capstan roller,

Fig. 40 is a schematic side view showing a further different example of capstan roller,

Fig. 41 is a schematic side view showing a further different example of capstan roller,

Fig. 42 is a schematic side view showing a further different example of capstan roller,

Fig. 43 is a schematic side view showing a further different example of capstan roller,

Fig. 44 is a schematic plan view showing a head detecting sensor of printing paper in a printing apparatus of the invention,

Fig. 45 is its schematic side view,

Fig. 46 is its explanatory view of an operation,

Fig. 47 is a schematic plan view showing a

thermal head and its positioning means in a printing apparatus of the invention,
 Fig. 48 is its schematic side view,
 Fig. 49 is an explanatory view showing the operation of positioning of the thermal head,
 Fig. 50 is an an explanatory view of operation of the thermal head and its positioning means,
 Fig. 51 is an explanatory view of an operation showing other example of thermal head and its positioning means,
 Fig. 52 is its schematic side view,
 Fig. 53 is a schematic plan view showing a different example of thermal head and its positioning means,
 Fig. 54 is an enlarged perspective view of the positioning means shown in Fig. 53,
 Fig. 55 is a schematic plan view showing the relation of thermal head and pressing member,
 Fig. 56 is its side view,
 Fig. 57 is a schematic plan view showing other relation of thermal head and pressing member,
 Fig. 58 is an enlarged perspective view of essential parts of Fig. 57,
 Fig. 59 is a schematic plan view showing a further different example of thermal head and its positioning means,
 Fig. 60 is an enlarged perspective view showing essential parts of Fig. 59,
 Fig. 61 is a schematic plan view showing cooling means of thermal head,
 Fig. 62 is its schematic side view,
 Fig. 63 is its explanatory view of operation,
 Fig. 64 is a schematic side view showing other example of cooling means of thermal head,
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 Fig. 84 is its explanatory view of operation,
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 Fig. 89 is an explanatory view of an operation of a paper discharge unit and its drive system,
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 Fig. 91 is its schematic side view,
 Fig. 92 is its explanatory view of operation, and
 Fig. 93 is its explanatory view of operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, some of the preferred embodiments of the invention are described in detail below.

Fig. 22 is a schematic side view of a printing apparatus of the invention, and Fig. 23 is a perspective view of its essential parts. In the drawing, numeral 1 denotes a feed unit for feeding printing paper P sheet by sheet, 2 is a discharge unit for collecting the printing paper P after printing, and 3 is a printing unit. The feed unit 1 and discharge unit 2 are stacked up vertically and disposed at one side in a box B, and the printing unit 3, comprising platen roller 6, thermal head 7, ink sheet cassette 8 and others, is disposed at the other side in the box B across a predetermined interval from the feed unit 1 and discharge unit 2.

Conveying paths P1, P2 of printing paper P are arranged between the printing unit 3 and feed unit

1, and discharge unit 2, and a conveying path P3 for switching back the printing paper P is formed behind the printing unit 3. The conveying path P2 linking the printing unit 3 and discharge unit 2 is formed in a nearly horizontal linear profile, and on the way it is joined with the conveying path P1 going from the feed unit 1 to the printing unit 3 at a predetermined angle. At the printing unit 3 side position from this junction point of the conveying paths P1, P2, a capstan roller 4 is disposed beneath, and a pinch roller 5 is located above, and a discharge roller 10 is installed just before the discharge unit 2. Besides, SE2 is a sensor for detecting and taking out the beginning portion of ink sheet S.

Fig. 24 is a schematic side view showing practically the constitution of essential parts shown in Fig. 22. In order to compose the conveying path P1, a stationary paper guide 51 is disposed beneath the feed unit 1, and other stationary paper feed guides 52, 53 are provided from the front end of the stationary paper guide 51 to the junction point of the conveying paths P1, P2. On the other hand, to compose the conveying path P2, a stationary paper guide 54 is disposed between the capstan roller 4 and discharge roller 10, and behind the platen roller 6, moreover, stationary paper guides 55, 56 are disposed above and below to compose the conveying path P3.

The conveying path of the printing paper P is described below by reference to the operation drawing shown in Fig. 25. The printing paper P sent out from the feed unit 1 by the paper feed roller 1a is conveyed between the stationary paper guides 51, 52, 53 as shown in Fig. 25 (a), and gets into the conveying path P2 from the conveying path P1, and is pinched between the capstan roller 4 and pinch roller 5 and conveyed, running through the platen roller 6 and thermal head 7, and is led behind into the conveying path P3 between the stationary paper guides 55, 56, and when the rear end portion of the printing paper P reaches a specified position between the platen roller 6 and thermal head 7, as shown in Fig. 25(b), the printing paper P is stopped, and the beginning of the printing paper P is led out.

The thermal head 7 descends together with the ink sheet S in the ink sheet cassette 8, and is pressed onto the printing paper P on the platen roller 6, and the platen roller 6 and capstan roller 4 are rotated reversely, and while the printing paper P is conveyed in the conveying path P2 to the discharge unit 2 side as shown in Fig. 25 (c), the thermal head 7 is energized, and printing is made through the heat generation unit 7a, and when printing is over, it is discharged intact into the discharge unit 2. In this process, in order to protect the integrated circuit disposed beneath the thermal

head 7, a part of the head cover 7d functions as the guide for the printing paper P.

In the case of color printing, meanwhile, the printing paper P is moved reciprocally between the platen roller 6 and thermal head 7 in the conveying path P2, through ink sheets S of different colors every time, to make printing plural times, and is discharged into the discharge unit 2.

[Constitution of conveying path of printing paper]

Fig. 26 is a schematic side view showing the case of composing a long conveying path P3 corresponding to a long printing paper P, in which stationary paper guides 57, 58 for composing the conveying path P3 behind the printing unit 3 are disposed after being curved upward along the side wall of the box B.

The other constitution and operation are substantially same as in the constitution of the printing apparatus shown in Fig. 25, and corresponding parts are identified with same reference numbers.

In such constitution, the free space in the box B may be effectively utilized, and the box B is prevented from becoming larger in size.

Fig. 27 is a schematic side view showing a further different example of the conveying path of the printing paper P, and Fig. 28 is an enlarged perspective view of its essential parts. In this embodiment, of the upper and lower stationary paper guides 55, 56 formed behind the platen roller 6, the front end portion of the stationary paper guide 55 is extended to the platen roller 6 side, and at the extended front end, a movable paper guide 59 is disposed.

The movable paper guide 59 is curved in a V-form as obvious from the side view in Fig. 28, and the curved portion is pivoted by the shaft 59a, in the hole 55a opened in the stationary paper guide 55, while a leaf spring 59c is abutting against the base end portion 59b, and the front end portion is always thrust and held in the direction of departing from the stationary paper guide 56 side by the leaf spring 59c.

The operation of this movable paper guide 59 is explained below together with enlarged explanatory views of operation in Fig. 29 to Fig. 31.

As shown in Fig. 29, while the thermal head 7 is at the waiting position, since the movable paper guide is pressed in its base end portion 59b by the leaf spring 59c, the front end portion side is positioned in the state being away from the stationary paper guide 56. When the thermal head 7 descends, first, as shown in Fig. 30, a part of the head cover 7d of the thermal head 7 abuts against the movable paper guide 59, and pushes it down and turns it about the shaft 59a by resisting the leaf spring 59c, and is positioned parallel to the front

end portion of the stationary paper guide 56 as shown in Fig. 31. When the thermal head 7 goes up, it returns to the position shown in Fig. 29 through the same process as above. As a result, the allowance for the printing paper P to be curved in the conveying path P3 is eliminated, and the positioning precision of the printing paper is heightened, and conveying troubles of the printing paper P can be prevented.

Fig. 32 is a perspective view showing other example of the movable paper guide 59, and in this embodiment, meanwhile, coil springs 60, 60 are externally fitted on the shaft 59a for pivoting the movable paper guide 59, and one end of the coil spring 60 is stopped on the movable paper guide 59, and the other end on the stationary paper guide 56, respectively.

In such an embodiment, the constitution may be simplified more than that in which the leaf spring 59c is used.

The other constitution and operation are substantially same as the movable paper guide 59 shown in Fig. 28, and corresponding parts are identified with same reference numbers, and explanations thereof are omitted.

[Constitution of paper feed unit]

Fig. 33 is a schematic side view showing a practical constitution of the feed unit 1, in which numeral 70 denotes a paper cassette for composing the paper feed unit 1. The paper cassette 70 is composed by disposing a middle casing 72 inside a rectangular outer casing 71 having the upper portion opened, and paper feed roller 1a and stationary paper guide 74 are disposed in the lower portion, and pushdown lever 75 and pressing lever 76 are disposed further in the upper portion.

The middle casing 72 comprises separation pawls 72a at both sides of the front bottom portion in the paper feeding direction of the printing paper P, an abutting piece 72b to contact with the front end of the push-down lever 75 above the middle portion, and a stopping piece 72c extending forward at the front end portion, and the both side walls of the rear end portion are pivoted on the side wall of the outer casing 71 by means of shaft 72d.

The stopping piece 72c extending to the front end side of the middle casing 72 is disposed on the spring retainer 71a in the state of being mounted on the dilating spring 71b stored in the spring retainer 71a disposed inside of the front end portion of the outer casing 71, and then is located between the upper and lower stoppers 71c, 71d, and is always in the state of abutting against the upper stopper 71c.

The paper feed roller 1a is disposed against

the middle of the lower portion of the outer casing 71, and it is designed to contact with the lower side of the printing paper P located at the lowest position of the stock of the printing papers P stored in the middle casing 72 when the middle casing 72 is pushed and turned downward. The push-down lever 75 and pressing lever 76 are pivoted coaxially on the shaft 77, and when they are rotated about the shaft 77 in the direction of arrow, the front end of the pressing lever 76 abuts against the contact piece 72b of the middle casing 72, thereby pushing down and turning the middle casing 72 about the shaft 72d. The stationary paper guide 74 is opposite to the front portion and front lower portion of the outer casing 71.

The operation of such feed unit 1 is explained below by reference to the explanatory view of operation shown in Fig. 34. Fig. 34 (a) shows the standby state of paper feed, and Fig. 34 (b) shows the paper feed state. In the standby state, the push-down lever 75 is rotated about the shaft 77 in the direction of arrow by a drive unit not shown, and its front end abuts against the contact piece 72b, and accordingly the lower side of the printing paper P stored in the middle casing 72 is pushed and turned to the position contacting with the paper feed roller 1a.

Next, as shown in Fig. 34 (b), the pressing lever 76 rotates in the arrow direction to abut on the upper surface of the printing paper P to further press the middle casing 72, and the lower surface of the printing paper P is pressed with a specified pressure against the paper feed roller 1a which is rotated and driven. By the frictional force acting between the paper feed roller 1a and printing paper P, the conveying force for the printing paper P is generated, and the printing paper P at the lowest position in the middle casing 72 is separated from other papers, and is sent out in the arrow direction, and is fed to the printing unit 3 side between the paper guides 74.

When feeding of the printing paper P is over, the pushdown lever 75 and pressing lever 76 return to the former position shown in Fig. 33, thereby finishing one cycle of paper feed operation. The printing paper P supplied from such feed unit 1 is transferred to the conveying path P2 through the conveying path P1 as clear from Fig. 22, and is pinched between the capstan roller 4 and pinch roller 5, and is conveyed to the printing unit 3 side.

[Practical constitution of capstan roller]

Fig. 35 is a schematic side view showing the printing unit 3 and the conveying path P2 in its vicinity, and Fig. 36 is a schematic plan view of the capstan roller 4 shown in Fig. 35. In the vicinity where the platen roller 6 and thermal head 7 are

opposing to each other, the capstan roller 4, which is a drive roller, is installed at the lower side across the conveying path P2 of the printing paper P, while the pinch roller 5, which is a driven roller, is disposed at the upper side, oppositely in upper and lower positions. The capstan roller 4 is composed by externally fixing the roller main body 4b made of metal or the like on the outer circumference of the shaft 4a.

On the surface of the outer circumference of the roller main body 4b, as shown in Fig. 36, projections 4c are regularly formed in a spiral form nearly at predetermined intervals at an angle α within 20° to 40° to the conveying direction of the printing paper P and at spiral pitch of 0.1 to 1 mm, and the crossing angle β of the lines linking projections positioned at the shortest distance of the projection row adjacent in the axial length direction is set to be 90° .

Consequently, the row of the projections 4c is positioned in a state slightly deviated in the peripheral direction of the capstan roller 4, and the projection 4c abuts against the printing paper P passing between the capstan roller 4 and pinch roller 5 at any position in the axial length direction, and by conveying the printing paper P with the projection biting in, slipping of the printing paper P and capstan roller 4 is prevented, and a strong conveying force capable of preventing disturbance of conveyance by external effect may be obtained.

When the projection 4c bites into the printing paper P, the surface of the printing paper P may be possibly damaged, but the capstan roller 4 having the projections 4c on the surface is located on the opposite side of the printing surface of the printing paper P and the pinch roller 5 is located at the printing surface side, so that the printing surface of the printing paper P may be protected, so that the printing quality will not be damaged.

If, incidentally, the arraying angle α of the projections 4c is 45° or more, and the crossing angle β is 90° or more, the present portion and absent portion of the projections are alternately formed in the peripheral direction of the capstan roller 4, and in certain regions the projections 4c do not contact with the printing paper P, and slipping may occur.

Fig. 37 is a schematic plan view showing other example of the capstan roller, and in this embodiment, projections 4c are formed at both ends in the axial length direction for a predetermined length in the axial length direction, respectively, and the middle portion in the axial length direction is free of projections 4c. In this way, by dividing the projection forming region on the surface of the capstan roller 4 into two positions in the axial length direction so that the projections may be present only in both end portions in the widthwise direction of the

printing paper P, the composition of the capstan roller 4 may be simplified, and it is possible to manufacture easily and at low cost, so that the cost may be saved.

The other constitution and action are substantially same as in the embodiment shown in Fig. 36, and corresponding parts are identified with same reference numbers and explanations are omitted.

Fig. 38 is a schematic plan view showing a further different example of the capstan roller, in which projections 4c, 4d are formed at both ends in the axial length direction for a predetermined length respectively, and the arraying directions of the projections 4c, 4d at both ends are mutually opposite, and the angle α to the conveying direction of the printing paper P is set at 30° .

Fig. 39 is a perspective view showing another different example of the capstan roller 4, in which a handle 65 is fixed or externally adhered to one shaft end of the capstan roller 4, preferably at one end of the maintenance door side.

The structure of the capstan roller is not particularly defined, but as shown in Fig. 36 to Fig. 38, for example, a row of projections 4c, 4d may be formed, or may not be formed as in the prior art.

The other constitution is substantially same as the constitution shown in Fig. 35, and the corresponding parts are identified with the same reference numbers.

In such an embodiment, by using the handle 65 for manually rotating the capstan roller 4, jamming of printing paper P near the platen roller 6 and capstan roller 4 may be easily cleared, and the reliability may be enhanced.

Fig. 40 is a perspective view showing a further different example of the capstan roller 4, and Fig. 41 is a partial sectional view showing the relation between the capstan roller 4 and outer plate 66, in which D-cut portion 4h is formed at one shaft end of the capstan roller 4, and the handle 65 has also a D-cut portion corresponding to this D-cut portion 4h so as to be inserted in the shaft 4h in its axial length direction.

The handle 65 has a flange portion 65a larger in outside diameter than its handle portion, and only the handle portion is exposed outside from a hole 66a smaller in diameter than the flange portion 65a pierced in the outer plate 66, and by inserting it or removing it (about 10 mm) into the position indicated by broken line or the position indicated by solid line shown in Fig. 41 as required, so that the handle 65 may be rotated easily. When the handle 65 is drawn out to the maximum extent, the flange portion 65a abuts against the back of the outer plate 66 to prevent it from slipping out of the shaft 4a.

In such an embodiment, when the handle 65 for manually rotating the capstan roller 4 is not

necessary, it is positioned inside the hole 66a, and when necessary, it can be drawn out from the hole 66a, and the handle 65 does not interfere the ease of manipulation.

Fig. 42 is a partial sectional view showing a constitution in which a door 67 is disposed in the part corresponding to the hole 66a of the outer plate 66, in which an outer door 67 for opening and closing the hole 66a is pivoted outside of the outer plate 66 in a state being thrust toward the closing side, so as to be rotated between the closing position and the opening position rotating 90° to the front side. Inside the door 67, there is a hole 67a nearly equal to the diameter of the hole 66a, and when the door 67 is rotated to the closing position, the hole 67a is opposite to the hole 66a, and the handle 65 is held at its front end in the state of projecting outward of the outer plate 66 by the length corresponding to the depth of the hole 67a as shown by broken line, so that the handle 65 may be drawn out easily.

After clearing paper jamming, by closing the door 67, the handle 65 is pushed inside of the 66a to return to the former position.

Fig. 43 is a schematic sectional view showing a different embodiment of the invention. Usually, when a motor of the type which generates a holding torque so that spontaneous rotation may not occur due to disturbance while not driving is used as the driving motor for the capstan roller 4, the motor holding torque becomes a large load, and manual rotation of the handle 65 is difficult.

In this embodiment, accordingly, when the handle 65 is drawn out to the manual operation position, the sensor SE2 detects it, and the current flowing into the motor which is the driving source is cut off, and the holding torque of the motor is cut off, and the load of the drive system is alleviated, and manual rotation is made easy to enhance the controllability.

The position detection sensor SE2 is composed of electric, magnetic or optical sensor, and when detecting the flange portion 65a of the handle 65, the current is cut off for the driving motor of the capstan roller 4, for example, the stepping motor.

The printing paper P caught between the capstan roller 4 and the pinch roller 5 is led into the conveying path P3 through the printing unit 3, and the rear end portion of the printing paper P is detected and taken out at the predetermined position.

Fig. 44 is a schematic plan view showing the configuration of the head detecting sensor of printing paper P in a printing apparatus of the invention, and Fig. 45 is its schematic side view. In the drawing, numeral 68 is a shaft disposed parallel to the shaft 4a of the capstan roller 4, and on this shaft 68 is supported a suspension frame 69 posi-

tioned at each end of the moving range of the printing paper P. Each suspension frame 69 is formed in an L-shape in side view as shown in Fig. 45, and each pinch roller 5 is supported rotatably between a pair of support pieces 69a, 69a projecting toward the direction of the platen roller 6, parallel to the capstan roller 4.

The other end of the suspension frame 69 is linked to a tension spring 69b, and each pinch roller 5 is contacting with it at the side of the capstan roller 4. In the middle of the mounting rod 69c straddling between the support pieces 69a of both suspension frames 69, the sensor SE3 for detecting the front end of the printing paper P is installed downward, with its detection point determined at position a shown in Fig. 45. Opposite to this detection sensor SE3, a reflector 69d is disposed below the moving range of the printing paper P. The position a which is the detection point of the sensor SE3 is set as being shifted to the opposite side of the platen roller 6 by the portion of L from the line b linking the axial center lines of the pinch roller 5 and capstan roller 4, and the position a is the beginning position of the printing paper P.

Positioning of the printing paper P is explained together with the explanatory view of operation shown in Fig. 46. Fig. 46 (a) shows the state of paper feed, and the thermal head 7 is waiting away above the platen roller 6. When the printing paper P is conveyed in the direction of the arrow by means of the pinch roller 5 and capstan roller 4, and led in between the stationary paper guides 55, 56, and the rear end of the printing paper P passes through the position a shown in Fig. 45, the fact above is simultaneously detected by the sensor SE3, and driving of the capstan roller 4 is stopped, thereby detecting the head as shown in Fig. 45.

Fig. 46 (b) shows the printing state, in which the thermal head 7 is lowered to contact the ink sheet S with the surface of the printing paper P, and the printing paper P is conveyed in the direction of arrow by the pinch roller 5 and capstan roller 4, and the heat generation unit 7a of the thermal head 7 is heated to make printing.

The detection sensor SE3 installed between the independent pinch rollers 5, 5 detects the front end of the printing paper P near the printing unit 3, by contrast to the beginning sensor SE of the printing paper P in the prior art as shown in Fig. 9, and therefore the head detecting precision of the printing paper P is enhanced. Besides, the pinch roller 5 is independently suspended, and if the mutual diameters of the pinch rollers 5 are slightly different, an equal feed speed is applied to the right and left sides of the printing paper P, so that the printing paper P may not run obliquely.

[Practical structure of thermal head]

Fig. 47 is a schematic plan view showing the thermal head 7 composing the printing unit 3 in a printing apparatus of the invention, and its support mechanism, and Fig. 48 is a schematic side view, and Fig. 49 is an explanatory view of operation for positioning the thermal head.

The thermal head 7 is installed at the lower side of the front end portion of a holding member 21 in a T-form in plan view, and its rear end portion is pivoted between the brackets 81a, 81a erected on the bush 81 externally mounted on the shaft 24, by means of a coupling shaft 83 in the state of being thrust to the platen roller 6 side through an intervening coil spring 82.

On the other hand, a pressing member 22 is similarly shaped in a T-form in plan view, and a pressing plate 22b is set between the front ends of the support arms 22a, and its rear end portion is integrally fixed to the shaft 24 with a set screw 22h. The pressing plate 22b is opposing upward to the front end portion of the holding member 21, and a contact spring 23 is intervening between it and the front end of the holding member 21.

Incidentally, numeral 22e is a stopper disposed on the upper surface of the front end portion of the holding member 21, and it is facing upward to the front end portion of the pressing member 22, and the relative position of the holding member 21 and pressing member 22 is regulated in the state of giving a proper dilating force to the contact spring 23.

Numeral 21f denotes radiation fins disposed on the holding member 21. At one end of the shaft 24, a gear 24b is provided, and through a reduction gear 24c which is engaged with this gear 24b, it is engaged with a worm gear 24d disposed on the output shaft of the motor M11, and the shaft 24 is rotated according to normal and reverse driving of the motor M11, and the holding member 21 and pressing member 22 are rotated about the shaft 24, and the thermal head 7 is pressed on the platen roller 6, or is departed therefrom.

On both sides of the front end portion of the holding member 21 for mounting the thermal head 7, as shown in Fig. 48, guide plates 21g are suspended, and guide pins 84a, 84a are projecting from the side frames 84, 84 above the both end portions of the platen roller 6 to above the platen roller 6, respectively. Each guide plate 21g is provided with a vertical portion 21m as shown in Fig. 48, and a slant portion 21n inclining at a predetermined angle to it, and when the thermal head 7 descends to the platen roller 6 side, the slant portion 21n of the guide plate 21g slides on the guide pin 84a, and when the thermal head 7 further goes down, the vertical portion 21m slides on the guide pin 84a, thereby positioning, as shown in Fig. 49, in the longitudinal direction of the thermal head

7 with respect to the platen roller 6, that is, in the conveying direction of the printing paper P.

The positioning operation of such thermal head is described below by reference to the explanatory view of operation shown in Fig. 50. Fig. 50 (a) shows the state of the thermal head 7 waiting upward, in which the holding member 21 and the pressing member 22 are thrust by the coil spring 82 and pushed out to the platen roller 6 side.

In consequence, when the shaft 24 is rotated by the motor M11 shown in Fig. 47, the pressing member 22 fixed therein is put in rotation, and the slant portion 21n of the lower end of the guide plate 21g abuts against the guide pin 84a, as shown in Fig. 50 (b). When the pressing member 22 is further rotated, the holding member 21 is rotated to the platen roller 6 side by the contact spring 23, and the guide pin 84a slides along the slant portion 21m of the guide plate 21g, and is pushed back to the bush 81 side.

When the pressing member 21 is further rotated, as shown in Fig. 50 (c), the thermal head 7 stops in the state of abutting against the platen roller 6, and the contact spring 23 is compressed, and the pressing force on the platen roller 6 is maintained. In this state, the thermal head 7 is energized to make printing.

Fig. 51 is a schematic plan view showing other example of thermal head 7 in a printing apparatus of the invention and its support structure, and Fig. 47 is its schematic side view.

In this embodiment, instead of the guide pin 84a as shown in Fig. 42, a detachable collar 85b is fitted to the pin 85a. By replacing such a guide pin 85 with a collar 85b having a different outside diameter, the position to be positioned of the platen roller 6 with respect to the thermal head 7 may be freely adjusted.

The other constitution and operation are substantially same as that of embodiment shown in Fig. 47 and Fig. 48, and the corresponding parts are identified with same reference numbers and explanations are omitted.

Fig. 53 is a schematic plan view showing a further different example of the thermal head 7 in a printing apparatus of the invention and its support structure, and Fig. 54 is a partially enlarged perspective view showing the mounting state of the guide pin shown in Fig. 53.

In this embodiment, instead of the guide pin 84a directly fitted to the side frame 84 as in the embodiment shown in Fig. 47, the guide pin 84a is disposed at a movable adjusting plate 86, and the movable adjusting plate 86 is fixed on the side frame 84 so as to be adjustable by means of set screw 86a. That is, as shown in Fig. 54, a slot 84b is disposed at the side frame 84 so as to extend in the direction parallel to the coupling shaft 83 (see

Fig. 53), in other words, in the conveying direction of the printing paper P, and with the guide pin 84a projected inward of the side frame 84 through the slot 84b, it is screwed and tightened to the side frame 84 by the set screw 86a through the slot 86b. Numerals 84c, 86c are graduations as the guideline for moving stroke of the movable adjusting plate 86.

In such a constitution, within the range of slot 84b, moving and adjusting the movable adjusting plate 86 in the conveying direction of the printing paper P with respect to the side frame 84, the front and rear positions of the thermal head 7 to the platen roller 6 may be adjusted to be equal to the right and left.

Fig. 55 is a schematic plan view showing other example of thermal head and support structure thereof in a printing apparatus of the invention, and Fig. 56 is its schematic side view.

In this embodiment, as a relative positioning stopper of the holding member 21 and pressing member 22 of the thermal head 7, instead of the stopper 22e shown in Fig. 53, a holding plate 87 is disposed on the upper side of the curved portion in a downward U-shape at the holder member 21, and a roller 88 is pivoted at a lower position of the holding plate 87 between right and left support arms 22a, 22a of the pressing member 22, and only the upward movement of the roller 88 is regulated by the holding plate 87.

As a result, when positioning the thermal head 7 on the platen roller 6, the holding member 21 smoothly slides in the longitudinal direction by the rotation of the roller 88.

Fig. 57 is a schematic side view showing a different example of the thermal head and its support mechanism in an printing apparatus of the invention, and Fig. 58 is its partially enlarged perspective view. In this embodiment, by making use of the repulsive force of two magnets 89, 90 magnetized in the vertical direction, only the upward motion of the pressing member 22 is regulated.

More specifically, the magnet 89 magnetized in the S pole at the upper side and N pole at the lower side as shown in Fig. 58 is fixed in the lower surface of the holding plate 87, and a mounting plate 22j is disposed between the support arms 22a of the pressing member 22 located beneath the holding plate 87, and the magnet 90 magnetized in the N pole at the upper side and S pole at the lower side is fixed on the mounting plate 22j. Hence, the opposing polarities repel against each other to regulate only the upward motion of the pressing member 22, while the longitudinal motion of the holding member 21 in the contact operation is not regulated, so that the smooth motion of the thermal head 7 is guaranteed.

Fig. 59 is a schematic plan view showing a still

different example of the thermal head and its support structure in a printing apparatus of the invention, and Fig. 60 is its partially enlarged perspective view. In this embodiment, in order to regulate the movement of the thermal head 7 in the axial length direction of the shaft 24, a stopper ring 91 abutting against one side of the bush 81 as shown in Fig. 47, and the spacer member 92 abutting against the other side, are fixed on the shaft, respectively, and outside the spacer member 92, a spring retainer 93 is fixed on the shaft 24, and a coil spring 94 is intervening between the spring retainer 93 and spacer member 92.

The spacer member 92 is formed in an upward U-shape as shown in Fig. 60, and the support arm 22a of the pressing member 22 is engaged with the shaft 24 in a manner of straddling over the portion fixed on the shaft 24, and by the dilating force of the coil spring 94, the bush 81 is thrust to the stopper ring 91 side.

[Cooling means of thermal head]

Fig. 61 is a schematic plan view showing the configuration applied to the thermal head showing the cooling means of the thermal head, and Fig. 62 is its schematic side view.

In the holding member 21 of the thermal head 7, in addition to the radiation fins 21f disposed at the position corresponding to the mounting position of the thermal head 7, there are radiation fins 21p also on the upper surface of the curvature formed at the base end side of the holding member 21, and a cooling fan 95 is installed above the radiation fins 21p.

Concerning such cooling means of the thermal head, the operation is described below by reference to the explanatory view of operation shown in Fig. 63. In the cooling means of such a thermal head 7, the heat generated from the heat generation unit 7a of the thermal head 7 is led into the radiation fins 21f, 21p through the holding means 21 by heat conduction, and is radiated therefrom, and moreover from the cooling fan 95, air is blown out always toward the radiation fins 21p side to promote cooling as indicated by arrow while the thermal head 7 is in waiting state as shown in Fig. 63 (a) or in the printing state as shown in Fig. 63 (b).

Besides, since the cooling fan 95 faces to the above of the radiation fins 21p disposed on the upper surface of the middle portion of the holding member 21 being small in the radius of rotation, even during printing action when the distance between the cooling fan 95 and thermal head 7 is the longest as in Fig. 63 (b), the distance to the radiation fins 21p is shorter than in the prior art as shown in Fig. 15, so that it is possible to cool

effectively. The operations of the holding member 21 and pressing member 22 of the thermal head 7 are substantially same as the cases shown in Fig. 47 and Fig. 48, and same reference numbers are given to the corresponding parts.

Fig. 64 is a schematic side view showing other example of the cooling means of the thermal head 7 in the printing apparatus, and Fig. 65 is a schematic plan view showing the moving mechanism of the cooling fan.

In the embodiment, the cooling fan F for cooling the thermal head 7 is movable, and while the thermal head 7 is in printing action, it comes closer to the thermal head 7, and when the thermal head 7 returns to the waiting position, it is drawn back to the position for avoiding interference.

Fig. 64 shows the constitution in which the cooling means of the invention in the conventional printing apparatus shown in Fig. 3 is applied, and while the thermal head 7 is at the printing position indicated by solid line in fig. 64, the cooling fan F is moved to the position indicated by solid line, and while the thermal head 7 is at the waiting position indicated by broken line, the cooling fan F is moved to the position indicated by broken line.

Fig. 65 shows the moving mechanism of the cooling fan F, in which numerals 97, 97 are guide rods disposed parallel to each other, and the cooling fan F is movably mounted on the both guide rods 97, 97 at its both ends through linear guides 98, 98. At the linear guide 98 of one side, a rack 98a is fixed, and this rack 98a is engaged and linked with a worm gear 99c disposed on the output shaft of a motor M12 through pinion 99a and gear 99b.

The operation of the above moving mechanism is explained below. In Fig. 59, when the thermal head 7 moves from the position of the broken line to the position of the solid line, the motor M12 begins to rotate simultaneously or somewhat later, and this operation is transmitted to the rack 98a by way of the worm gear 99c, gear 99b, and pinion 99a, and the cooling fan F is moved in the axial direction of the guide rods 97, 97 through the linear guides 98, 98, and stops near the thermal head 7.

When the thermal head 7 returns to the position of broken line, the motor M12 begins to rotate reversely at the same time or somewhat later, and the cooling fan F is drawn back to avoid interference with the thermal head 7.

The other constitution and operation are substantially same as in the conventional apparatus shown in Fig. 2, and corresponding parts are identified with the same reference numbers, and are not explained again.

Fig. 61 is a schematic plan view showing other example of a cooling fan F, in which the cooling fan F has a support rod 100 disposed at one end, and

the end of the support rod 100 is fixed on the output shaft of a motor M13. Such a cooling fan F is moved in an arc form within the horizontal plane according to normal and reverse rotation of the motor M13, and when the thermal head 7 is at the printing position, it moves to the position indicated by solid line, and when the thermal head 7 returns to the waiting position, it escapes in advance to the position indicated by broken line.

[Practical constitution of ink sheet cassette and its drive unit]

Fig. 67 is a perspective view showing the state of mounting the ink sheet cassette 8 on a cassette case 106, Fig. 68 is a partial sectional view along line of VI-VI in Fig. 67, Fig. 69 is an exploded view, Fig. 70 is a perspective view showing the coupling state of the reel device and bobbin of the ink sheet cassette, and Fig. 71 is a perspective view of the state of dismounting the ink sheet cassette 8 from the case 106.

The ink sheet cassette 8 comprises, as shown in Fig. 69, cylindrical portions 101, 101 for incorporating a bobbin 105a containing an unused ink sheet S, and a bobbin 105b for taking up the used ink sheet S, which are coupled into one body by means of a coupling portion 102 having a communicating passage. The cassette case 106 is composed by integrally coupling with a coupling portion 108 cylindrical holding portions 107, 107 for holding the cylindrical portions 101, 101 of the ink sheet cassette 8, and the coupling portion 108 is provided with a stopper 109 for preventing the cassette 8 from slipping out so as to be movable in the vertical direction, or specifically between the detaching region of the ink sheet cassette 8 and the withdrawn position.

The ink sheet cassette 8, as shown in Fig. 69, contains bobbins 105a, 105b in its cylindrical portions 101, 101, and the ink sheet S is installed in the cassette case 106 as being put on the cylindrical portions 101, 101 through the passage of the coupling portion 102, and the front end portions of the bobbins 105a, 105b are coupled to the reel devices 110, 110 respectively as shown in Fig. 67.

The bobbins 105a, 105b are substantially identical in structure, and a practical structure of the bobbin 105a is shown in Fig. 70. A flange 105c is disposed on the outer circumference of the opening at one end of the bobbin 105a, and a guide tube 105e having inner blades 105d at plural positions in the inner circumference is provided in the opening.

The reel device 110 has a shaft 110b of square column form in the middle of one side of the gear 110a, and a ring with blade 110c having a square hole is fitted therein, and a coil spring 110d is

intervening between the ring with blade 110c and gear 110a, and the ring with blade 110c is thrust toward the shaft end side. Numeral 110e is a stopper externally fixed to the shaft end portion. On the other hand, the gear 110a of the reel device 110 coupled with the bobbin 105a is engaged with a gear 111 fixed on the output shaft of a motor M14 as shown in Fig. 69.

The operation of such a cassette is explained together with the explanatory views in Fig. 71 and Fig. 72. The ink sheet cassette 8 is usually installed in the cassette case 107 as shown in Fig. 67 by against the dilating force of the coil spring 110d shown in Fig. 67, and a shaft 110b of the reel device 110 is inserted into the bobbins 105a, 105b, and the ring with blade 110c is engaged in the guide tube 105e of the bobbins 105a, 105b to be stopped together with the inner blade 105d, and when the motor M14 is rotated, the bobbin 105b is rotated through the gear 111 and gear 110a, so that the ink sheet S is moved from the bobbin 105a to 105b.

On the other hand, in the state shown in Fig. 67, when the stopper 109 is moved in the direction of arrow, the dilating force of the coil spring 110d of each reel device 110 thrust with dilating force in the state shown in Fig. 72 is released, and the ink sheet cassette 8 is pushed out in the arrow direction from the cassette case 106 as shown in Fig. 71, and at the same time coupling of ink sheet cassette 8 with reel device 110 is released.

In such an embodiment, only by moving the stopper 109 to the release position, the ink sheet cassette 8 may be easily taken out of the cassette case 106 by making use of the dilating force of the coil spring 110d, and the slide mechanism of the cassette storage magazine and ink sheet cassette 8 as in the prior art shown in Fig. 18 is not needed, and the number of parts may be decreased.

Fig. 73 is a perspective view showing other example of the reel device, in which, instead of the ring with blade 110c in Fig. 72, a ring with blade 112 having a base portion 110f is used in a state of integrally coupling portions between the blades at one end of the gear 110a side.

The other constitution is same as in Fig. 72, and corresponding parts are identified with same reference numbers, and explanations are omitted.

In such a constitution, the contact area of the reel device 110 and each bobbin increases, and the dilating force of the coil spring 110d is uniformly transmitted to all bobbins, so that the ink sheet cassette 8 may be pushed out securely.

Fig. 74 is a side view showing a different embodiment of the reel device, in which plural dampers 113 are installed between gear 110a and ring 112 with blade of the same structure as shown in Fig. 73.

In this constitution, the dilating force of the coil spring 110d is relaxed and transmitted to the ring 112 with blade, and the ink sheet cassette 8 is moderately pushed out from the cassette case 106.

The other constitution and operation are substantially same as the embodiment shown in Fig. 73, and corresponding parts are identified with same reference numbers, and explanations are omitted.

[Ink sheet head detecting sensor]

Fig. 75 is a schematic plan view of ink sheet S. The ink sheet S has leader marks Na, Nb, Nc, Nd at the beginning of each color region of Y, M, C, that is, at the moving direction side, as shown in Fig. 75. For example, when detecting the beginning of the yellow region Y, the ink sheet S is stopped at the position where the marks Na and Nb are simultaneously detected by the head detecting sensors SE1, SE1 (see Fig. 23). To detect the beginning of the magenta region M, the mark Nc is detected by one sensor SE1, and for the cyan region C, the mark Nd is detected by one sensor SE1, so that each color region of the ink sheet S is detected.

Fig. 76 is a perspective view showing a case of applying the ink sheet detecting sensor to the conventional apparatus shown in Fig. 8 and Fig. 9, and Fig. 77 is its side view. As the head detecting sensor SE1 for ink sheet S, the reflection type sensor is used because it is less affected by the heat of the thermal head 7.

A pair of detecting sensors SE1, SE1 are installed at a predetermined interval on a stay 69c so as to confront with a reflector 7f disposed on the front surface of the thermal head 7 at the waiting position above the platen roller 6. The lower end edge of the reflector 7f has the front end formed in a curvature so as to serve also as the guide of the ink sheet S.

The head detecting motion of ink sheet S is explained by reference to the explanatory view of operation shown in Fig. 78. Fig. 78 (a) shows the head detecting state of the printing paper P and ink sheet S, in which the printing paper P is conveyed from the arrow direction by the pinch roller 5 and capstan roller 4, and it stops at the position where the front end thereof is detected by the sensor SE, and the leader is pulled out.

On the other hand, the thermal head 7 is lowered until its reflector 7f confronts the sensors SE1, SE1, and in the process of the ink sheet S being taken up in the arrow direction, when the marks Na and Nb shown in Fig. 75 are detected, the movement of the ink sheet S stops, and the yellow region Y is led out.

Fig. 78 (b) shows the printing state, in which

the thermal head 7 descends to press the ink sheet S to the printing paper P, and the printing paper P is conveyed in the arrow direction by the pinch roller 5 and capstan roller 4, and the thermal head 7 is heated to make printing.

In such a constitution, the detecting sensors SE1, SE1 confront the reflector 7f when the thermal head 7 comes to the head position of the ink sheet S, and therefore the time exposed to the heat effect of the thermal head 7 is short, so that its function may not be sacrificed.

[Constitution of discharge roller]

Fig. 79 is a schematic side view showing other constitution of a paper discharge roller in a printing apparatus of the invention, and Fig. 80 is a schematic side view showing the drive system in the state shown in Fig. 79. In this embodiment, instead of the discharge roller 10 shown in Fig. 24, a feed/discharge roller 121 is used as the drive roller serving both feeding and discharging, and as the driven rollers to roll thereon, pinch rollers 122, 123 are disposed.

The feed/discharge roller 121 is located between conveying paths P1, P2 near the junction point of the conveying path P1 for paper feeding and conveying path P2, and the pinch roller 122 is disposed to roll on the feed/discharge roller 121 across the conveying path P1, and the pinch roller 123 is disposed to contact with and depart from the feed/discharge roller 121 across the conveying path P2.

In Fig. 80, a rotary lever 125 which supports the feed/discharge roller 121, pinch roller 122, and pinch roller 123 is directly pivoted on a frame 120 or on a support frame not shown through a shaft 125a in a state of not interfering with an sliding lever 124. The sliding lever 124 is formed like a rod, and in the middle of the longitudinal direction, slots 124a, 124b extending in the longitudinal direction are engaged with guide pins 120a, 120b projecting to the side face of the frame 120 so as to be movable reciprocally in the lateral direction, and at one end thereof a pin 124c is provided to contact with a stopping piece 125d of a rotary lever 125, while a pin 124d engaged with a cam groove 126b of a cam gear 126 is provided at the other end side.

The rotary lever 125 has at its support piece 125b pivoting with the pinch roller 123, and a stopping piece 125d having an engaging recess 125c abuts against a pin 124c projecting from the sliding lever 124, and furthermore the stopping piece 125e is linked with the frame 120 through a tension spring 125f, and it is always thrust and held in the arrow direction by the tension spring 125f. A cam gear 126 is pivoted on the frame 120 through

a shaft 126a, and is engaged and linked with a worm gear 128 of a motor M14 through a worm wheel 127.

On the side surface of the cam gear 126, a groove 126b is formed, and a pin 124d projecting from the sliding lever 124 is inserted into this groove 126b, and the sliding lever 124 is moved reciprocally in the arrow direction by the rotary shaft of the motor M14.

Fig. 81 is an explanatory view of operation of the drive system shown in Fig. 80, in which both pinch rollers 122, 123 are rolling on the feed/discharge roller 121. That is, in Fig. 80, when the motor M14 is driven and the cam gear 128 is rotated in the arrow direction, the pin 124d engaged in the groove 126b is moved away from the center of rotation of the cam gear 126, and the sliding lever 124 is moved in the direction of arrow in Fig. 81, and the pin 124c abutting against the stopping piece 125d of the rotary lever 125 is engaged with the engaging recess 125c. As a result, the rotary lever 125 thrust by the tension spring 125f is rotated in the direction of arrow, so that the pinch roller 123 rolls on the feed/discharge roller 121.

The operation of such feed/discharge roller 121 and pinch rollers 122, 123 is explained together with the explanatory views of operation shown in Fig. 82 to Fig. 84.

Fig. 79, Fig. 80 show the state of paper feed, in which the feed/discharge roller 121 and feed pinch roller 122 are rotated in the direction of arrow respectively, and the printing paper P is conveyed from the feed unit 1 to the printing unit 3 side in the arrow direction. At this time, the capstan roller 4 and pinch roller 5 are rotating respectively in each arrow direction, and the printing paper P is conveyed into the conveying path P3 through the portion between the platen roller 6 and thermal head 7 by the capstan roller 4 and pinch roller 5. When the rear end of the printing paper P reaches the specified position and is detected, the rotations of the feed/discharge roller 121 and capstan roller 4 stop temporarily, and the platen roller 6 moves upward, and the printing paper P is pressed against the thermal head 7 through the intervening ink sheet S as shown in Fig. 82.

At the position contacting with the printing paper P, the head of yellow region Y of the ink sheet S is detected, and the thermal head 7 is heated and the yellow ink is transferred on the printing paper P to record the yellow image, while the printing paper P is conveyed to the conveying path P2 side. When recording of the yellow image is over, after the capstan roller 4 stops temporarily, the platen roller 6 descends in the arrow direction and is departed from the thermal head 7, and, as shown in Fig. 83, the capstan roller 4 and pinch

roller 5 are rotated and driven in the arrow direction, and the head of printing paper P is returned to the beginning position. At the same time, the ink sheet S is forwarded to search the head of next magenta region M.

When the printing paper P returns to the head position again, the capstan roller 4 stops rotating temporarily, and the platen roller 6 goes up again in the arrow direction, and the printing paper P is pressed against the thermal head 7 through the ink sheet S, and the magenta image is recorded over the already recorded yellow image. When the recording of magenta image is over, the cyan image is similarly recorded, and color printing is over.

When color printing is over, as shown in Fig. 81 and Fig. 84, the pinch roller 123 is pressed against the feed/discharge roller 121, and the printing paper P is discharged toward the discharge unit 2.

In such an embodiment, the printing paper P is fed by the feed/discharge roller 121 and pinch roller 122 for feeding paper which is always pressed thereto, working in pair, when the pinch roller 123 is pressed against the feed/discharge roller 121, they work as a pair to discharge printing paper P, so that one feed/discharge roller 121 may be used for both feeding and discharging paper, and the number of rollers required for feeding and discharging the printing paper P may be reduced, while the driving force transmitting mechanism may be simplified, and the number of parts decreases.

[Practical constitution of discharge unit]

Fig. 85 is a perspective view showing the drive system in the discharge unit 2, in which a reel device 110 linking with the ink sheet cassette and discharge unit 2 of printing paper P which has finished printing are driven by one motor M15. At a predetermined interval from the gear 110a installed in the reel device 110 shown in Fig. 67 and Fig. 68, a pulley integrated gear 131 and gear 132 with one-way clutch function are provided. The gear 110a, pulley integrated gear 131, and gear 132 composing one-way clutch are disposed with their axial center lines mutually directed parallel to each other, and the pulley integrated gear 131 and gear 132 are engaged with a worm wheel 133 disposed coaxially, and the gear 110a with a gear 132, respectively.

Fig. 86 is an exploded perspective view and explanatory view of operation of one-way clutch. The gear 132 composing the one-way clutch is fitted to slide in the axial length direction on a shaft 133a of the worm wheel 133 as shown in Fig. 86 (a), and as shown in Fig. 86 (b) the torque of the worm wheel 133 is transmitted to the gear 132 through the shaft 133a when the worm wheel 133

rotates about the shaft 133a in the direction of arrow, and the gear 132 also rotates together in the arrow direction, and on the other hand, as shown in Fig. 86 (c), when the worm wheel 133 rotates in the arrow direction, if the gear 132 is loaded, the shaft 133a and gear 132 idle, and the torque of the worm wheel 133 is not transmitted to the gear 132.

Therefore, the pulley integrated gear 131 is rotated together with the motor M15 even when the motor M15 rotates in any direction, but when the reel device 110 is rotated together with the motor M15 when the motor M15 runs in one direction, but is not rotated when the motor M15 runs in the opposite direction.

Therefore, the pulley of the pulley integrated type gear 131 is linked with the pulley of the pulley integrated bevel gear 136 through the rubber belt 135, and this pulley integrated bevel gear 136 is engaged with the bevel gear 137a which composes a torque limiter 137. The torque limiter 137 has a bevel gear 137a and pulley 137b disposed coaxially, and as shown in Fig. 87 (a), while the bevel gear 137a is rotating in the arrow direction, unless the pulley 137b is loaded as specified, the torque of the bevel gear 137a is transmitted to the pulley 137b, so that the pulley 137b also rotates together in the arrow direction.

On the other hand, as shown in Fig. 87 (b), when the pulley 137b is loaded more than specified, slipping occurs between the bevel gear 137a and pulley 137b, and the torque of the bevel gear 137a is not transmitted to the pulley 137b. The pulley 137b, as clear from Fig. 85, is linked to a pulley 139 through a rubber belt 138 on which a discharge lever 140 is mounted on the way. The front end portion of the discharge lever 140 is formed like a fork, and this front end portion is projecting upward from beneath the paper guide plate 141 through the guide grooves 141a, 141b, and by the rotation of the rubber belt 138, the discharge lever 140 is designed to move reciprocally in the arrow direction along the guide grooves 141a, 141b.

The operation of thus composed drive system is explained together with the explanatory views of operation shown in Fig. 88 and Fig. 89. In Fig. 88, the worm wheel 133 is rotated in the arrow direction by the rotation of the motor M15, and in this case as shown in Fig. 86 (b), the gear 132 having the one-way clutch mechanism is rotated together in the arrow direction, and the gear 110a of the reel device 110 engaged therewith rotates in the arrow direction, thereby taking up to detect the beginning of the ink sheet S.

Besides, by the rotation of the pulley integrated gear 131, the pulley integrated bevel gear 136 rotates in the arrow direction, but since the discharge lever 140 abuts against the ends of the

grooves 141a, 141b disposed in the paper guide plate 140 and the rotation in the arrow direction of the pulley 137b is loaded, slipping occurs between the bevel gear 137a and pulley 137b, and the pulley 137b does not rotate.

The printing paper P having been finished to be printed is sent out onto the paper guide plate 141 from the arrow direction as indicated by single dot chain line in Fig. 88, and is positioned by the guide plate not shown.

Fig. 89 shows the case where the motor M15 rotates reversely from the state shown in Fig. 88, and the worm wheel 133 is rotated in the direction of the arrow, in which as shown in Fig. 86 (c), the shaft 133a and gear 132 idle, and the gear 110a does not rotate, and the reel device 110 stops. On the other hand, the pulley integrated gear 133 is rotated in the arrow direction, and the pulley integrated bevel gear 136 is rotated through the rubber belt 135, and the bevel gear 137a of the torque limiter 137 is rotated in the arrow direction.

In this state, since load is not applied to the rotation of the pulley 137b in the arrow direction, and the pulley 137b is also rotated together in the arrow direction, and moves the discharge lever 140, and discharges the printing paper P in the direction orthogonal to the previous conveying-in direction. As the discharge lever 140 is further moved to reach the ends of the grooves 141a, 141b provided in the paper guide 141 as shown in Fig. 89, the pulley 137b is loaded, and slipping occurs between the bevel gear 137a and pulley 137b, and the rotation of the pulley 137b stops.

Fig. 90 is a schematic plan view showing other example of the discharge unit 2, and Fig. 91 is its schematic side view. On the paper guide plate 141, the printing paper P is conveyed from the arrow direction in the same way as in the previous embodiment.

In the region of the conveyance of the printing paper P onto the paper guide plate 141, holes 141c, 141d are formed against both sides of the conveying direction of the printing paper P, and conveying rollers 151, 152 are disposed above and beneath the paper guide plate 141 against these holes 141c, 141d in mutually contacting state. The upper conveying roller 151 is a driving roller, and is fixed on the shaft 153.

The shaft 153 is provided with worm wheel 154 and pulley 155, and is coupled with the motor M15 through a worm gear 156 engaged with the worm wheel 154, and is linked with a pulley 158 disposed on the shaft 157 through the pulley 155 and worm gear 156.

The shaft 157 is provided with a gear 159 with one-way clutch function, together with a pulley 158, and the gear 159 idles on the shaft 157 while the conveying roller 151 is driven so as to convey the

printing paper P onto the paper guide plate 141, or the motor M15 is rotating normally, and rotates together with the shaft 157 when the motor M15 is rotating reversely, thereby transmitting the output of the motor M15 to a cam gear 161 through a reduction gear 160.

The cam gear 161 has a pin 161a projecting at a position closer to the peripheral portion of the side face as shown in Fig. 91, and the pin 161a is inserted into a slot 162b in the longitudinal direction formed in an erecting piece 162a of an sliding lever 162. The sliding lever 162 is linked with a discharge block 164 through an swinging lever 163.

The sliding lever 162 and swinging lever 163 are disposed beneath the paper guide plate 141 parallel thereto. Pins 141e, 141f provided on the paper guide plate 141 are inserted into slots 162b, 162c formed at the sliding lever 162 in a direction parallel to the conveying direction of the printing paper P, and a pin 163b provided on the swinging lever 163 is inserted in a slot 162d formed in a direction orthogonal to the extending direction of the slots 162b, 162c, so as to move reciprocally in the arrow direction accompanying the rotation of the cam gear 161.

On the other hand, the swinging lever 163 is pivoted beneath the paper guide 141 by the shaft 163a, and is linked with the sliding lever 162 through the pin 163c disposed on one arm thereof, while a pin 164a disposed at the discharge block 164 is inserted in the hole 163c disposed on the other arm, thereby rotating about the shaft 163a accompanying the reciprocal move of the swinging lever 163.

The discharge block 164 is installed in a guide groove 141g extending in a direction orthogonal to the conveying direction of the printing paper P formed in the middle of the paper guide plate 141, so as to be movable reciprocally in the arrow direction through pins 164a, 164b, and a pair of stopping pieces 164c for pushing out the printing paper P are disposed in the upper portion, and as the swinging lever 163 rotates about the shaft 163a, the printing paper P is carried out in the arrow direction orthogonal to the conveying direction, so as to be discharged into a discharge tray not shown.

The operation of thus composed discharge unit 2 is described below while referring to the explanatory views of operation in Fig. 92 and Fig. 93. First, in Fig. 90 and Fig. 91, the torque of the motor M15 is transmitted to conveying rollers 151, 151 through worm gear 156, worm wheel 154 and shaft 153, and the conveying rollers 151, 151 are rotated in the arrow direction respectively as shown in Fig. 92, and the printing paper P is conveyed into the paper guide plate 141 from the arrow direction shown in Fig. 90. At this time, idling occurs be-

tween the shaft 157 and the gear 159 having one-way clutch function, and the discharge block 164 is in stationary state.

When the printing paper P is completely pushed out onto the paper guide plate 141, it is released from between the conveying rollers 151, 152, and the motor M15 rotates reversely. The torque of the motor M15 is transmitted to the cam gear 161 through the worm gear 156, worm wheel 154, shaft 153, rubber belt 166, shaft 157, gear 159 and reduction gear 160, and the cam gear 161 is rotated in the arrow direction shown in Fig. 92. The sliding lever 162 moves parallel in the arrow direction shown in Fig. 92 (a), and the swinging lever 163 rotates in the arrow direction about the shaft 163a, and the discharge block 164 moves in the arrow direction, thereby pushing out the printing paper P in the arrow direction by the stopping pieces 164c, 164c.

Fig. 93 shows the state where the cam gear 161 rotates by 180° from the state in Fig. 92 and the printing paper P is about to be discharged from the paper guide plate 141. The cam gear 161 keeps rotating further, rotating 360° from the state in Fig. 92 to return to the state in Fig. 92, when the discharge block 164 is pulled back to the former position shown in Fig. 90, and the motor M15 stops rotating, and discharge action is over. Again, the motor M15 is put in normal rotation, and the head of the ink sheet S is detected and led out, and thereafter the same operation is repeated.

In a such drive system, by discharging the printing paper P conveyed onto the paper guide plate 141 by the conveying roller 151 by force, the printing paper P is discharged securely to prevent paper jamming and other troubles, and since the specified discharge action is over when the cam gear 161 makes one revolution, the discharge block 164 may be removed reciprocally only by varying the rotating direction of the motor M15, and moreover by using the gear 159 having one-way clutch function, transfer of the printing paper P by the conveying roller and discharge of the printing paper P by the discharge block 164 may be effected by one motor M15, and the number of motors required is smaller, which contributes to downsizing of the apparatus and enhancement of the reliability.

In the present invention, the first conveying path from the printing unit to the discharge unit is nearly linear, and it joins on its way with the second conveying path from the feed unit to the printing unit, so that the conveying path of the printing paper is shortened, and conveying troubles of the printing paper may be decreased, and the size may be further reduced.

In the present invention, also, since the paper feed port is disposed at the bottom of the paper cassette, the conveying path until the paper to be

fed is taken into the conveying path is shortened, and the constitution is simplified, and the reliability is heightened by decreasing the paper conveying and feeding troubles.

In the present invention, also, since the conveying roller is provided with slide preventive means on the printing paper, the printing paper may be positioned accurately, and dislocation of printing position and color deviation may be prevented, and hence the printing quality may be improved.

Further, in the present invention, the printing head is accurately moved and positioned on the platen roller, and color deviation in color printing may be prevented, and the printing quality may be enhanced further.

Furthermore, in the present invention, since the printing head is held tiltably so as not to be parallel to the platen roller, and therefore the printing head is pressed with a uniform pressure on the platen roller, that is, on the printing paper, so that the printing density may be uniform.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, and the present embodiments are therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within meets and bounds of the claims, or equivalent of such meets and bounds thereof are therefore intended to be embraced by the claims.

Claims

1. A printing apparatus comprising a printing paper feed unit, a printing unit for printing on the printing paper, a printing paper discharge unit, and a printing paper conveying path for connecting said printing paper feed unit and discharge unit with said printing unit,

wherein said conveying path comprises a first conveying path linking said printing unit and said discharge unit and extending almost linearly to allow said printing paper to move reciprocally, and a second conveying path linking said feed unit and printing unit and joining said first conveying path on the way.

2. A printing apparatus comprising a printing paper feed unit, a printing unit for printing on said printing paper, a printing paper discharge unit, and a printing paper conveying path for connecting said printing paper feed unit and discharge unit with said printing unit,

wherein said feed unit has a paper cassette provided with a paper feed port in the bottom.

3. A paper feed unit of a printing apparatus being provided with a paper cassette which comprises a paper feed port at the bottom thereof and pawl member having separation pawls for holding both side portions of the down stream side of the printing paper, and a paper feeding roller which is pressed against the printing papers from lower side to generate friction force and takes out the lowest printing paper from said separation pawls to feed it from said paper feed port by said friction force at paper feeding, comprising:

means for positioning said pawl member at the position where said pawl member is housed in said paper cassette at stand-by state, and at the position where said pawl member depends from said paper cassette with predetermined distance at paper feeding state;

press down means for pressing down said pawl member downwardly and generating conveying force between said paper feed roller and the printing paper by applying pressing force to the printing papers contained in said paper cassette at the transition state from said stand-by state to said paper feeding state; and

a paper guide which is provided at lower portion of the down stream side of said paper cassette, and guides the printing paper conveyed from said paper cassette.

4. A printing apparatus comprising a printing paper feed unit, a printing unit for printing on the printing paper by transferring ink of an ink sheet with applying a predetermined electric signal to said thermal head and passing the printing paper interposing said ink sheet between said thermal head and a platen, and a printing paper discharge unit, comprising:

a paper cassette, at said paper feed unit, which houses the printing papers;

a paper feed roller which takes out the printing paper one by one from said paper cassette;

a conveying roller which conveys the printing paper taken out by said paper feed roller;

an ink sheet winding roll which winds up the used ink sheet;

an ink sheet feeding roll which feeds the unused ink sheet;

an ink sheet cassette which contains said ink sheet winding roll and said ink sheet feeding roll, and is mounted at the position where said platen contacts with ink side of said ink sheet;

a discharge roller which discharges the printing paper after printing; and

a paper guide which guides the printing

paper to move the printing paper in predetermined direction at paper conveying and printing processing.

5. A printing apparatus comprising a printing paper feed unit, a printing unit for printing on the printing paper by transferring ink of an ink sheet with applying a predetermined electric signal to said thermal head and passing the printing paper interposing said ink sheet between said thermal head and a platen, and a printing paper discharge unit, comprising:

a paper cassette, at said paper feed unit, which houses the printing papers and has a paper feed port for feeding the printing paper from lower side thereof;

a paper feed roller which is disposed below said paper cassette and takes out the printing paper one by one from said paper cassette;

a conveying roller which conveys the printing paper taken out by said paper feed roller; and

a paper guide which guides the printing paper to move the printing paper in predetermined direction.

6. A printing apparatus comprising a printing paper feed unit, a printing unit for printing on the printing paper, a printing paper discharge unit, and a printing paper conveying path for connecting said printing paper feed unit and discharge unit with said printing unit,

wherein a conveying roller equipped with sliding preventive means for said printing paper is disposed facing said conveying path.

7. A printing apparatus comprising a printing paper feed unit, and a printing unit for printing on the printing paper, comprising

a capstan roller as a driving roller which conveys the printing paper and a pinch roller as a driven roller which is disposed opposite to said capstan roller,

wherein said capstan roller is disposed at reverse side of printing face of the printing paper and said pinch roller is disposed at the printing side of the printing paper, and

said capstan roller has, at surface thereof, projection rows regularly arranged at an angle direction with respect to the paper conveying direction within a predetermined range and at an interval whose direction is perpendicular to said angle direction within a predetermined range.

8. A printing apparatus as set forth in Claim 7, wherein

said predetermined range of angle direction is 20° to 40°, and

said predetermined range of interval is 0.1 mm to 1.0 mm.

9. A printing apparatus as set forth in Claim 7, wherein

said projection rows at the surface of said capstan roller is divided into two portions at axial direction of said capstan roller and is disposed at both end portion of the printing paper.

10. A printing apparatus as set forth in Claim 7, wherein

said capstan roller is provided with a handle which enables to manually rotate said capstan roller.

11. A printing apparatus as set forth in Claim 7, comprising:

a handle, at said capstan roller, which enables to manually rotate said capstan roller, and

means for moving said handle in the axial direction of said capstan roller.

12. A printing apparatus as set forth in Claim 7, comprising:

a sensor which detects that said handle is drawn out from the apparatus;

a motor as a driving source of said capstan roller which generates holding torque for preventing from free rotation by disturbance at applying voltage in the case where said motor does not drive; and

means for cutting current to said motor in the case where said sensor detects that said handle is drawn out from the apparatus.

13. A printing apparatus comprising a printing paper feed unit, and a printing unit having a printing head which moves close and separated with respect to a platen roller, wherein

said printing head is supported by a supporting member movable in front and reverse direction with respect to the conveying direction of the printing paper, and is positioned at predetermined position of said platen roller by a guide member at moving to printing position.

14. A printing apparatus comprising a printing paper feed unit, and a printing unit having a printing head which moves close and separated with respect to a platen roller, wherein

said printing head is supported by a supporting member tiltable with respect to the axis of said platen roller.

15. A printing apparatus comprising a printing paper feed unit, and a printing unit for printing on the printing paper by transferring ink of an ink sheet with applying a predetermined electric signal to said thermal head and passing the printing paper interposing said ink sheet between said thermal head and a platen, wherein, said pinch roller is composed of a plurality of rollers which are suspended independently, and disposed coaxially and symmetrically in axial direction, and

a sensor for detecting the front end of the printing paper is provided at center of said rollers, and a reflector for said sensor is provided at opposite position thereof.

16. A printing apparatus comprising a printing paper feed unit, and a printing unit for printing on the printing paper by transferring ink of an ink sheet with applying a predetermined electric signal to said thermal head and passing the printing paper interposing said ink sheet between said thermal head and a platen, comprising:

above said pinch roller, a sensor, having an emitting unit and a receiving unit, for detecting a predetermined mark on said ink sheet to searching the head of said ink sheet; and

at the end surface of said thermal head, a reflector of said sensor and serving for a guide of said ink sheet; and

wherein the mounting angle of said sensor is adjusted opposite to said reflector at the time when said thermal head reaches to the position where the head of said ink sheet is detected.

17. A printing apparatus comprising a cassette which contains a feeding side bobbin formed cylindrical shape and on which an ink sheet is wound, and a winding side bobbin formed cylindrical shape and winding said ink sheet under the state in which one end of each said bobbin is exposed to the outside and parallelly, and makes said bobbin rotate within a surface perpendicular to the center axis thereof to wind up said ink sheet by transmitting torque to said wind up side bobbin, comprising:

a wing which engaged with the one end of said bobbin exposed from said cassette and transmits torque to said bobbin;

a reel disk which slidable supports said wing, has a shaft whose sliding length is long enough, and rotates integrally with said wing;

a spring which pushes said wing to engage said bobbin and said wing, and has extending force strong enough to discharge said cassette out to the apparatus;

a guide which slidably supports said cassette, and

a stopper which stops said cassette in the apparatus against said extending force of said spring, and releases extending force of said spring when necessary.

18. A printing apparatus which holds the printing paper by pressing between a thermal head and a platen roller, and prints the printing paper by heating said thermal head with conveying the printing paper, comprising:

a right and left frame;

a pair of pins, at said right and left frame, which has axis parallel to the axis of said platen roller; and

a guide plate, at both end of a holding member holding said thermal head, which contacts said pins, and positions said thermal head;

wherein the other end of said holding member is supported by a supporting bush which is rotatably pivoted by supporting shaft of said thermal head through a spring which forces said guide plate in the direction to be always contacted with said pins.

19. A printing apparatus as set forth in Claim 18, comprising:

a roller which is rotatably mounted parallel to the axis of said platen roller at pressing member for contacting said thermal head to said platen roller, and presses said holding member by being fixed and rotating through said spring, and

a regulating plate which is fixed at said holding member and regulates only upwardly movement of said rollers.

20. A printing apparatus as set forth in Claim 18, comprising:

two magnets being magnetized in vertical direction, and one of which is fixed at said holding member and the other is fixed at a pressing member in the manner that the same pole of both magnets are opposite each other,

whereby only upward movement of said pressing member by the reaction of said spring is regulated.

21. A printing apparatus as set forth in Claim 18, wherein

said bush is forced in axial direction thereof at one end by a stop ring which fits within a supporting shaft of said thermal head, and at the other end by a slid spring which is inserted into said supporting shaft of said thermal head.

22. A printing apparatus comprising a printing unit which transfers ink of an ink sheet with winding said ink sheet by an ink sheet conveying unit, discharge unit which discharges the printing paper after transferring ink, and a driving power transmitting unit which transmits driving power from a motor as a power source necessary for conveying said ink sheet and discharging the printing paper, being provided with

a one way clutch and a torque limiter at said driving power transmitting unit.

23. A printing apparatus as set forth in Claim 22, wherein, at said power transmitting unit

in the case where said motor rotates in a predetermined direction, said one way clutch transmits driving power to said ink sheet by rotating together,

in the case where said motor rotates in reverse direction, said one way clutch does not transmit driving power to said ink sheet by not rotating together, and

in said both cases, driving power is transmitted to said discharge unit, and after completion of predetermined operation of said discharge unit, driving power is not transmitted to said discharge unit by slipping said torque limiter.

24. A printing apparatus which holds the printing paper by pressing between a thermal head held by holding plate supported by supporting arm and a platen roller, and prints the printing paper by heating said thermal head with conveying the printing papers, comprising:

radiation fins at both said of holding plate and said arm of said thermal head.

25. A printing apparatus comprising a thermal head for transferring ink of an ink sheet, and a cooling fan for cooling said thermal head, wherein said thermal head is controlled so as to heat at a first position for printing, and not to heat at a second position for not printing

means for, in the case where said thermal head is at said first position, making said cooling fan be close up to said thermal head, and in the case where said thermal head is at said second position, said cooling fan be separate from said thermal head.

26. A printing apparatus as set forth in Claim 25, wherein

said cooling fan is provided with a linear guide for supporting and moving along straight line.

27. A printing apparatus as set forth in Claim 25,
wherein
said cooling fan is provided with a rotating
mechanism for supporting and rotating.

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Fig. 1
Prior Art

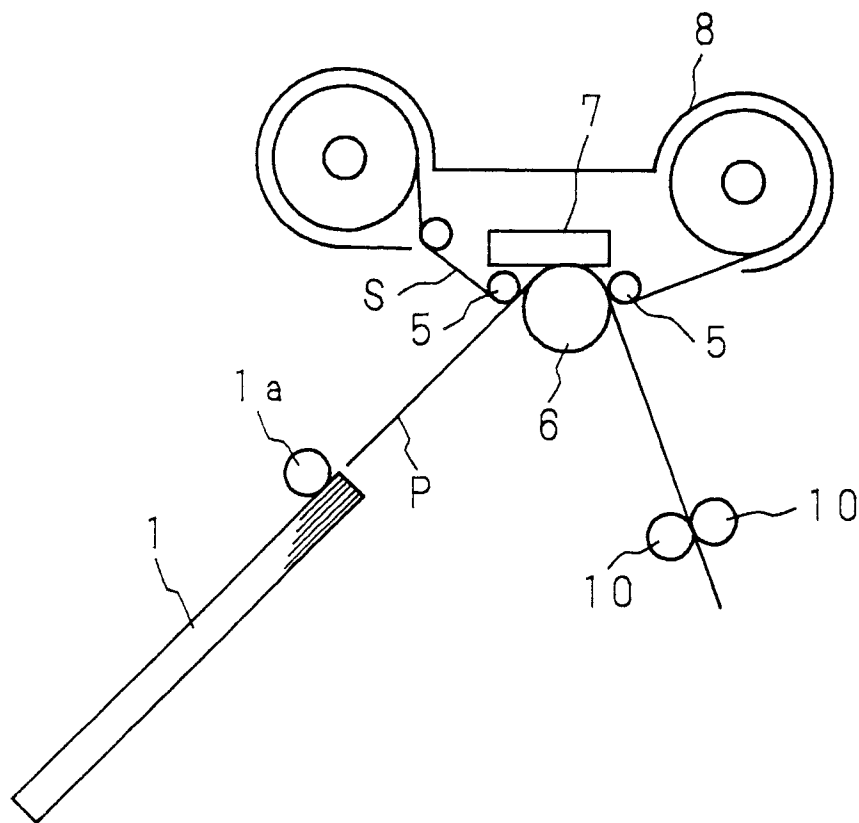


Fig. 2(a)
Prior Art

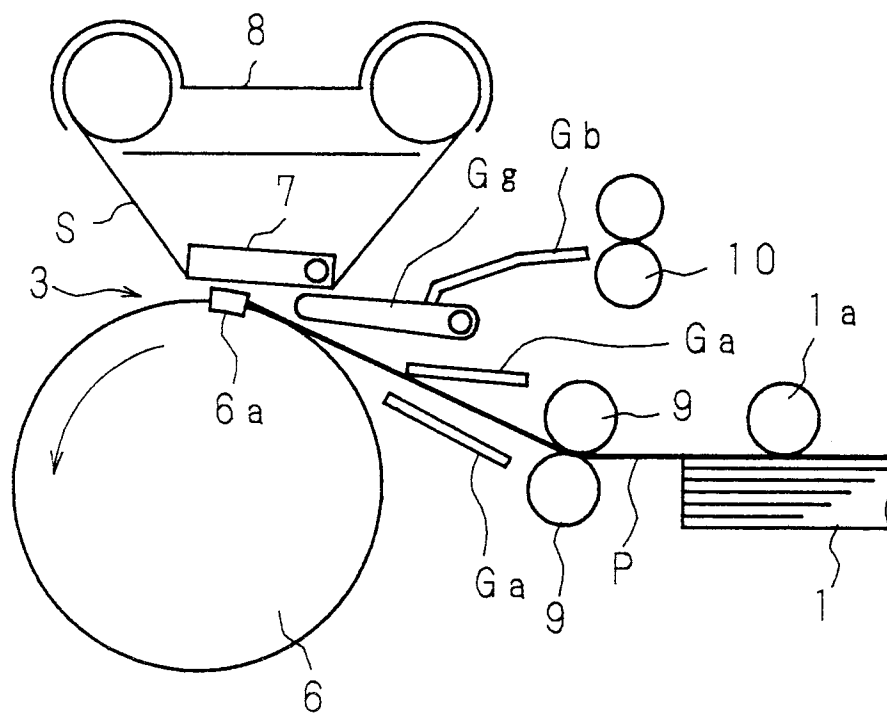


Fig. 2(b)
Prior Art

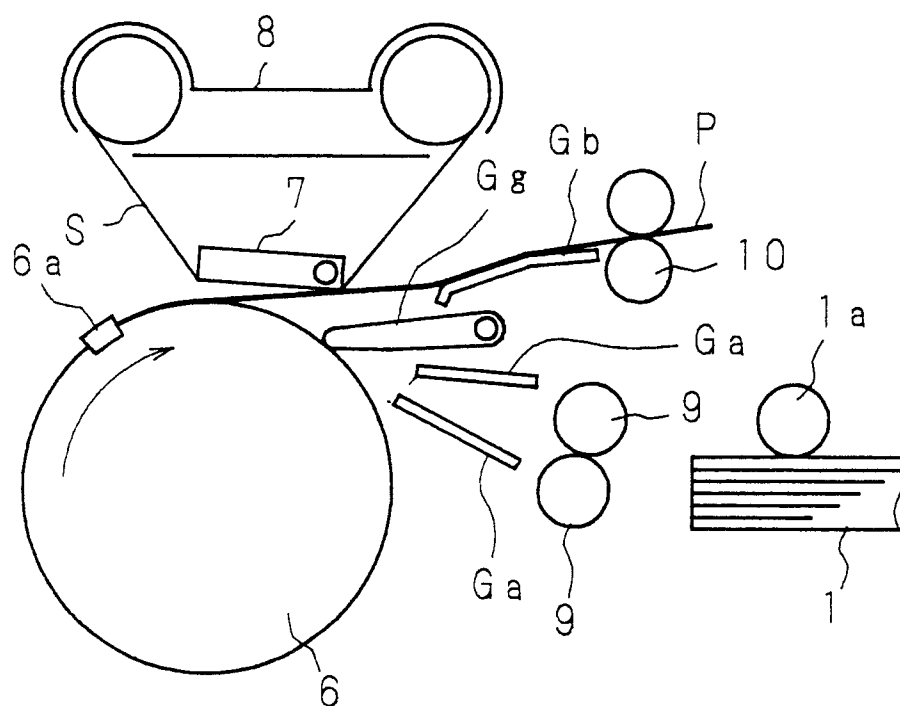


Fig. 3
Prior Art

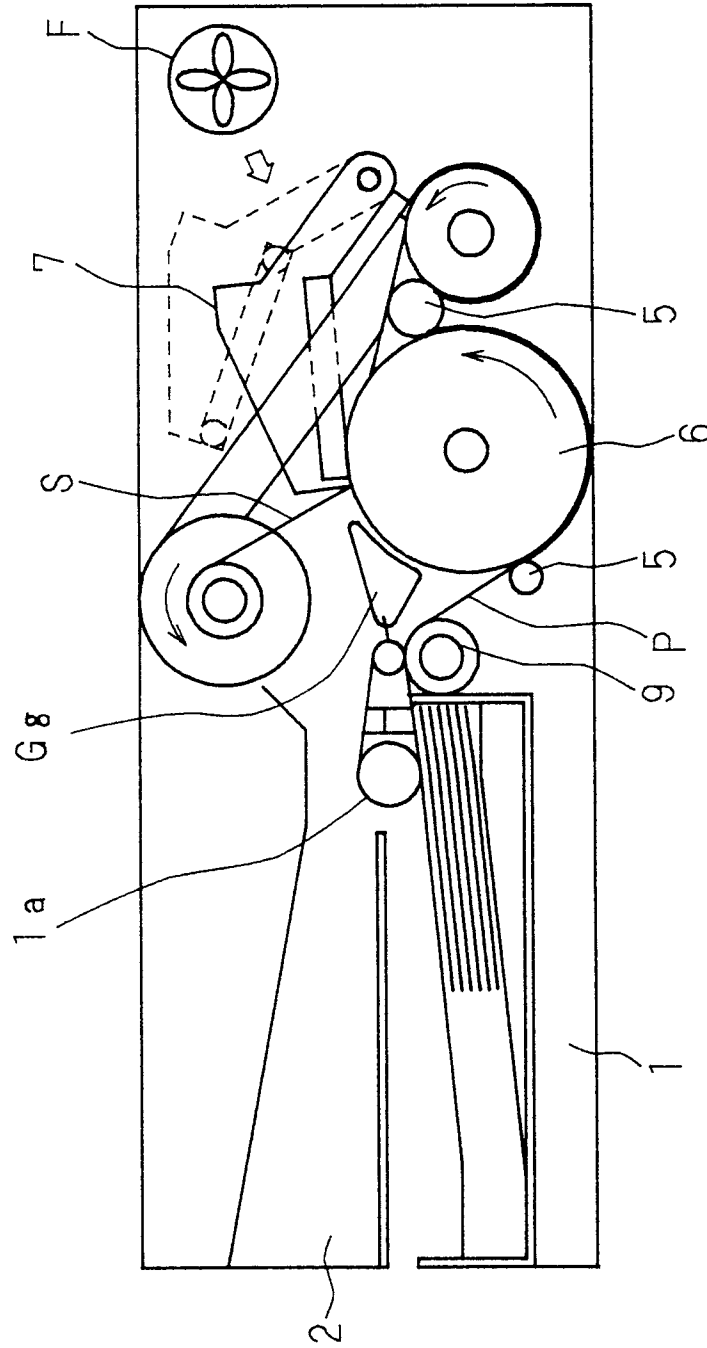


Fig. 4
Prior Art

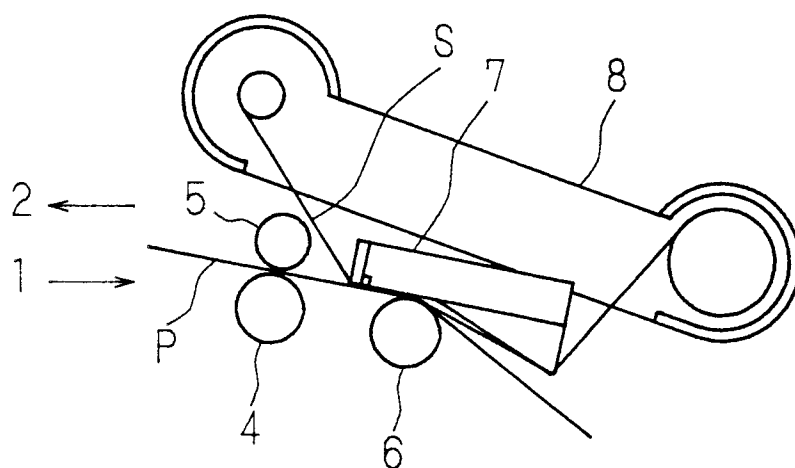


Fig. 5
Prior Art

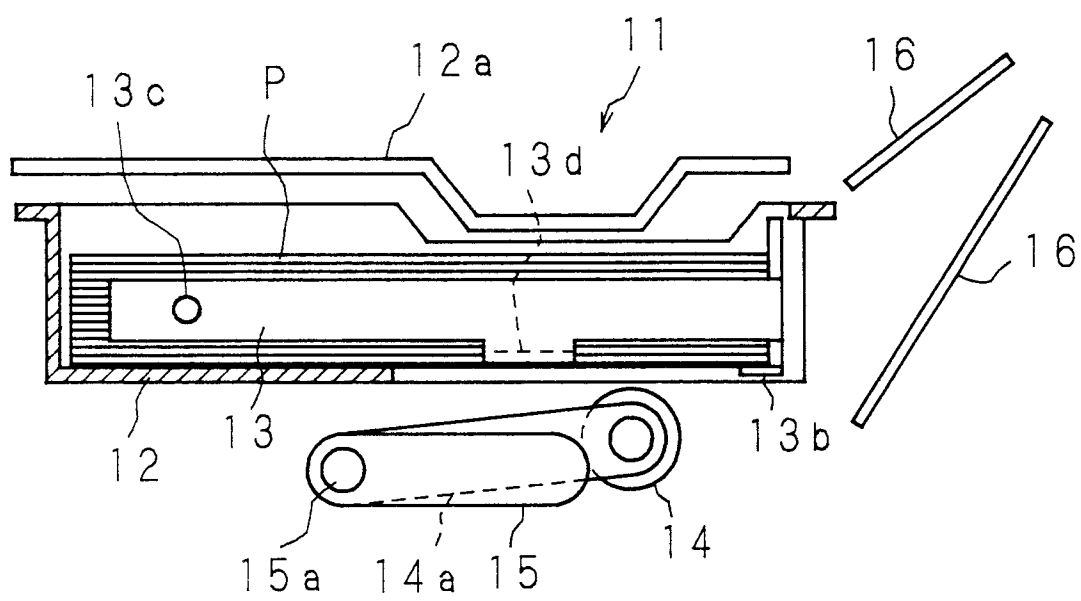


Fig. 6
Prior Art

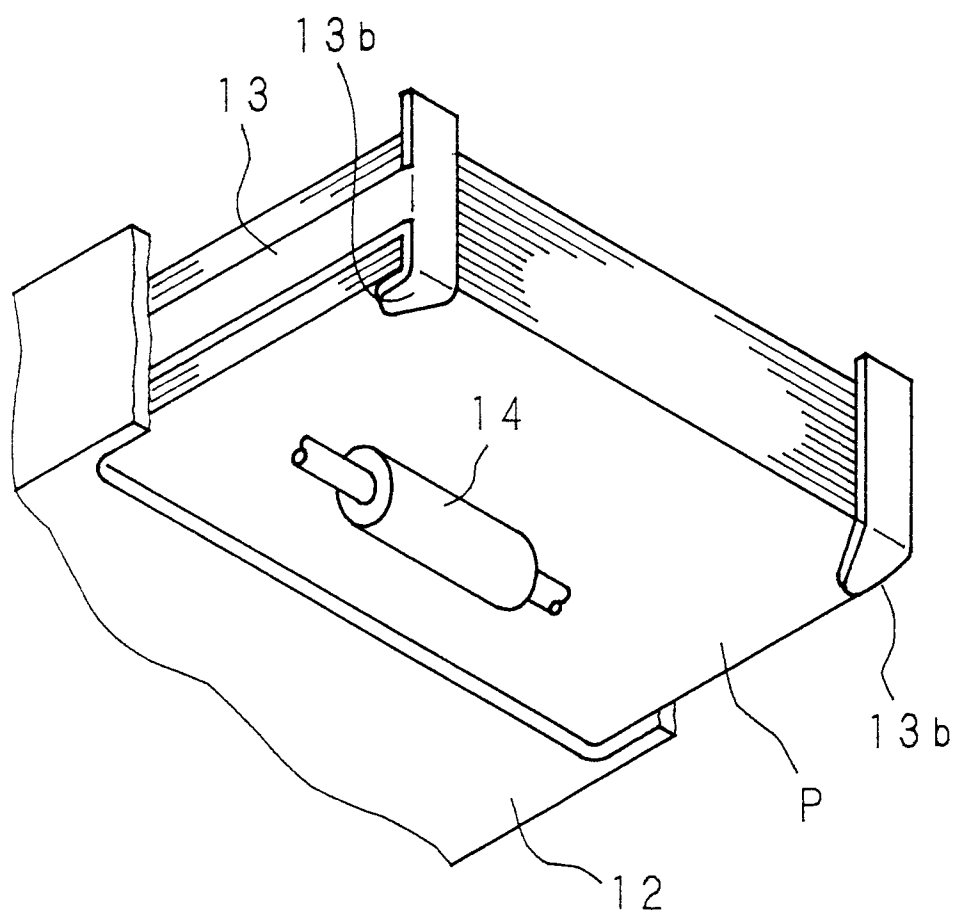


Fig. 7
Prior Art

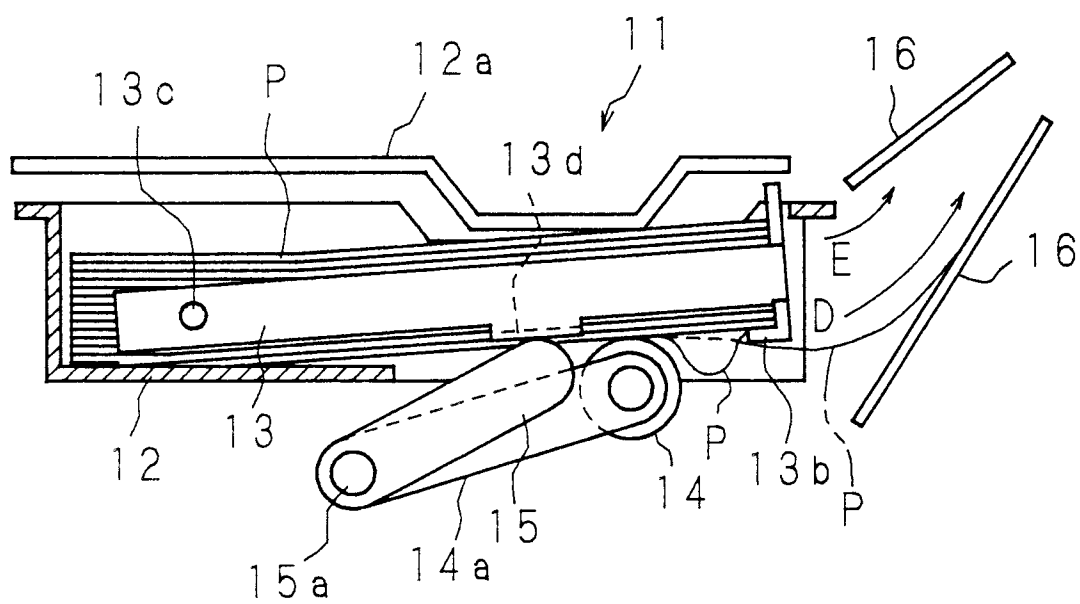


Fig. 8
Prior Art

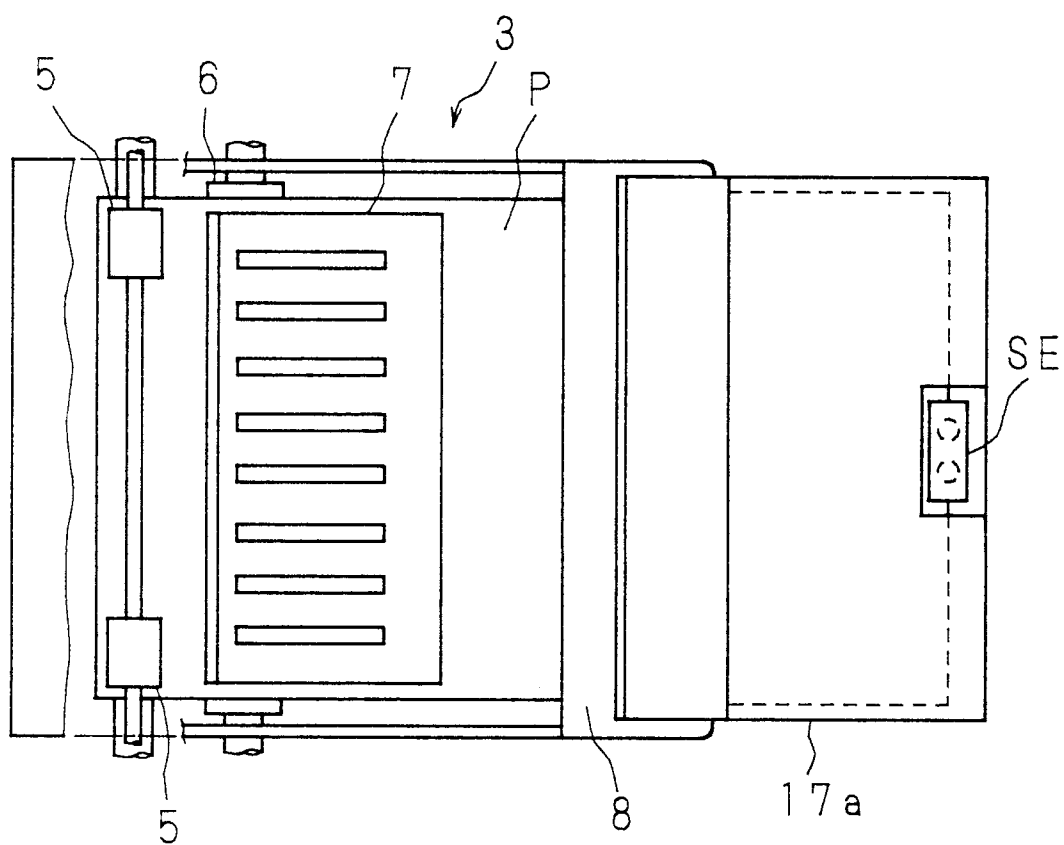


Fig. 9
Prior Art

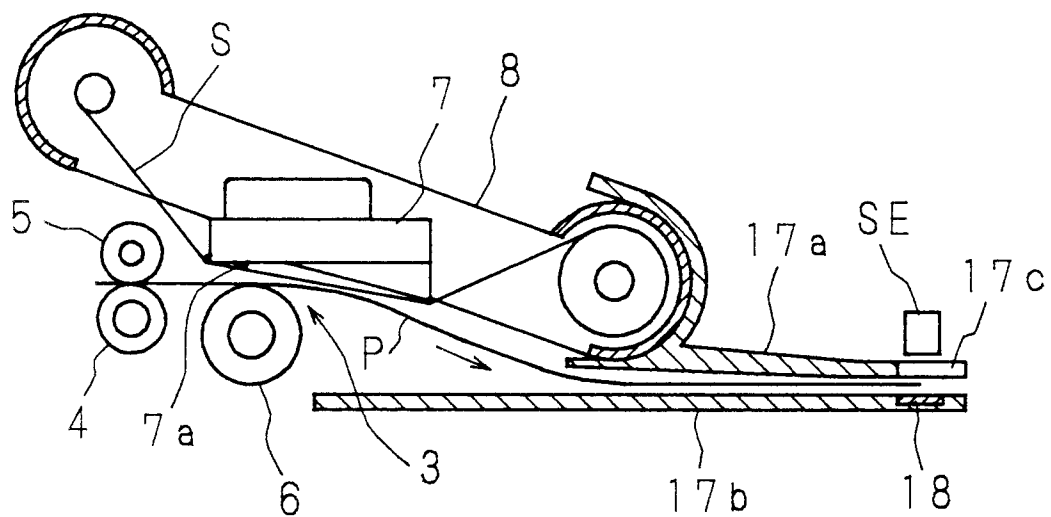


Fig. 10
Prior Art

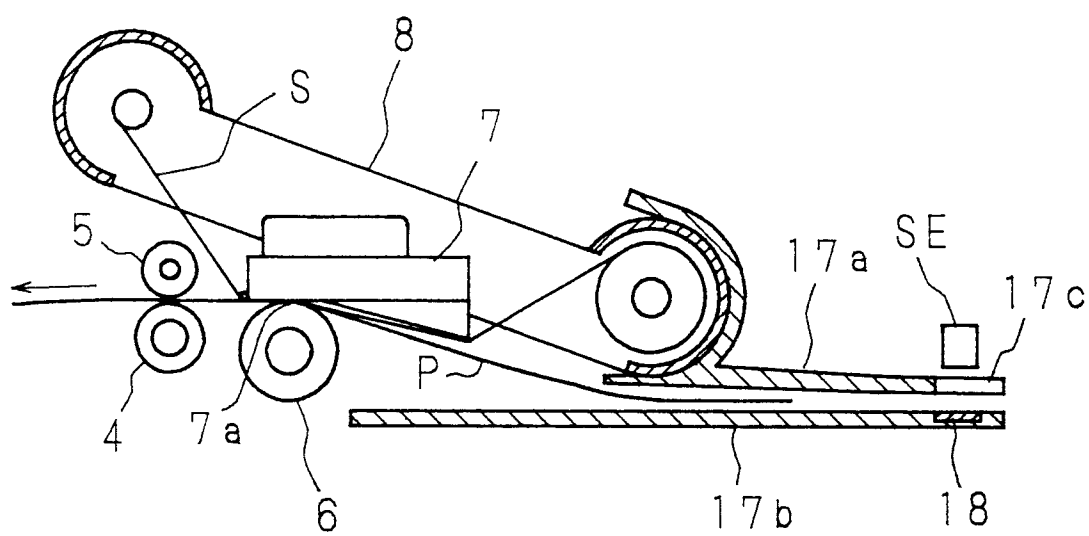


Fig. 11
Prior Art

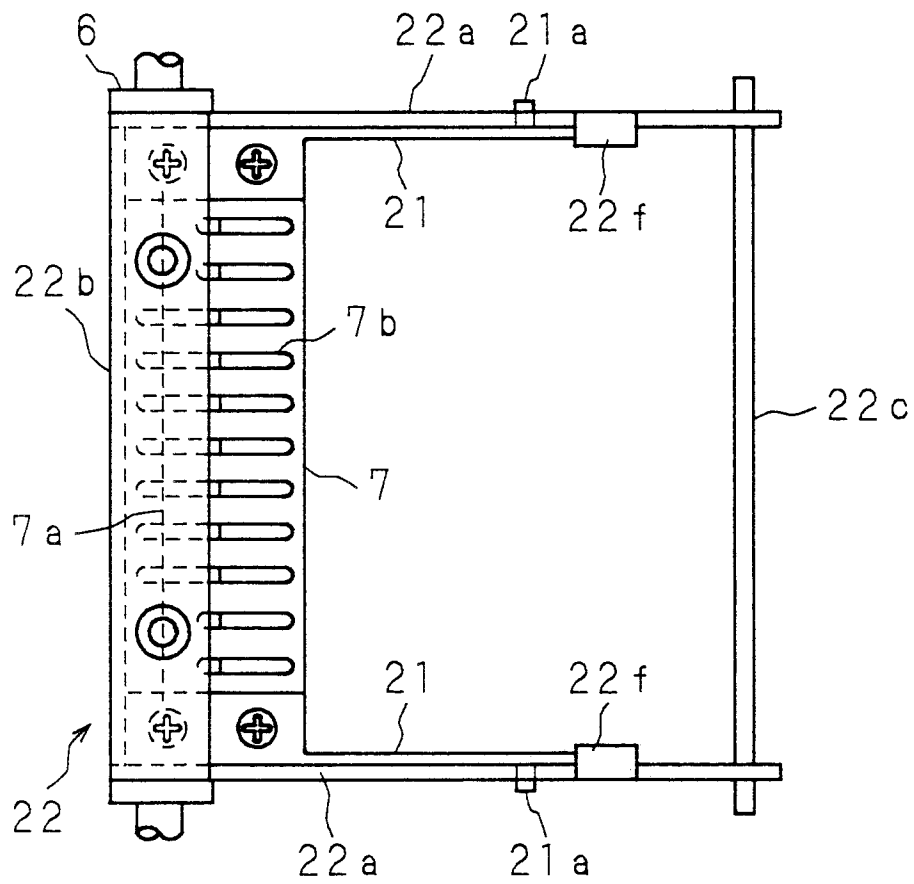


Fig. 12
Prior Art

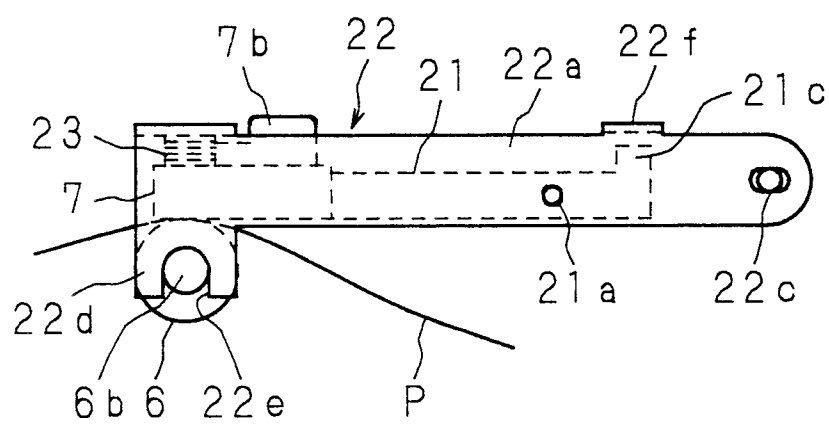


Fig. 13(a)
Prior Art

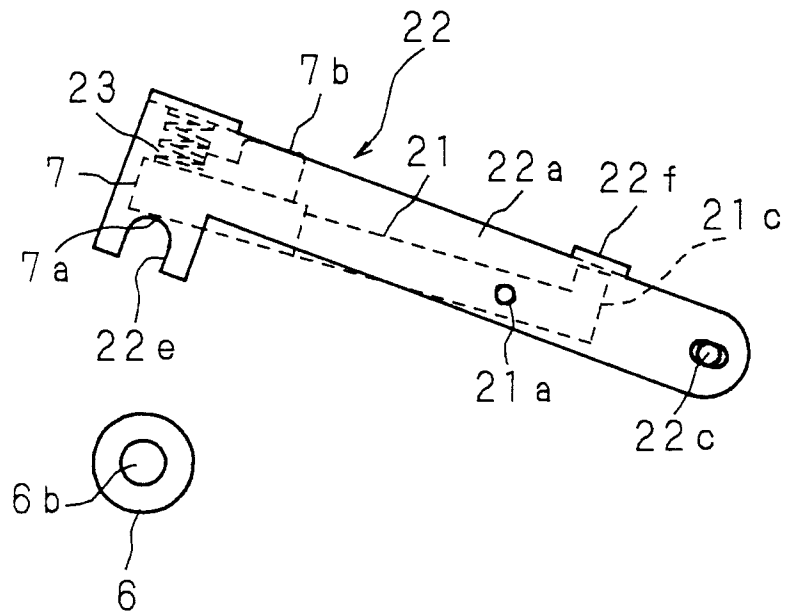


Fig. 13(b)
Prior Art

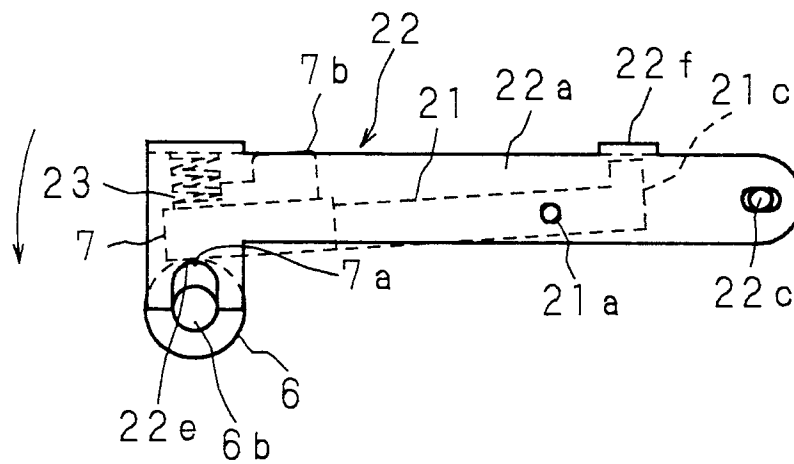


Fig. 14
Prior Art

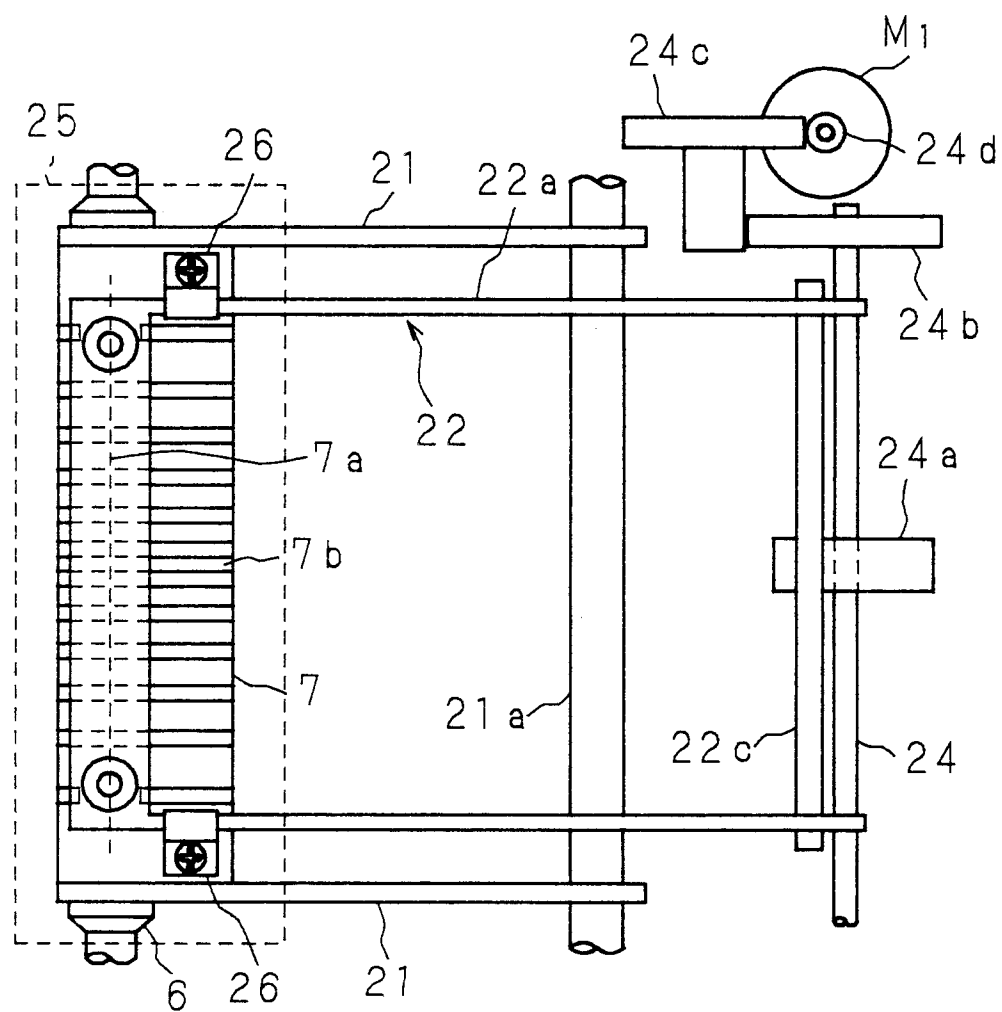


Fig. 15
Prior Art

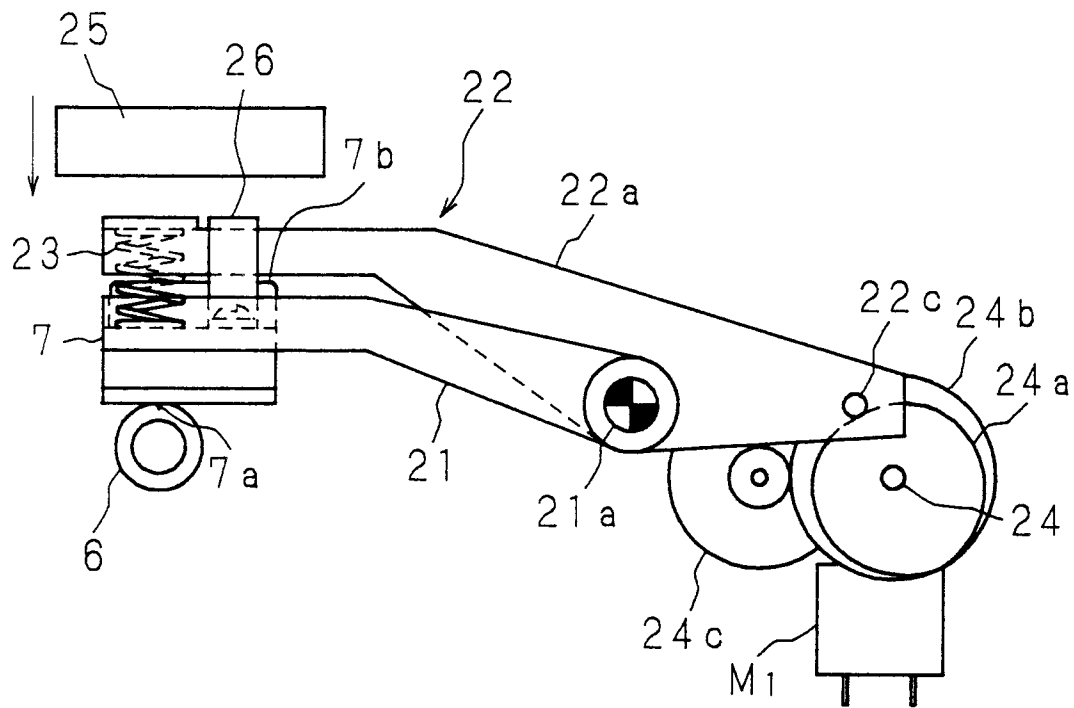


Fig. 16
Prior Art

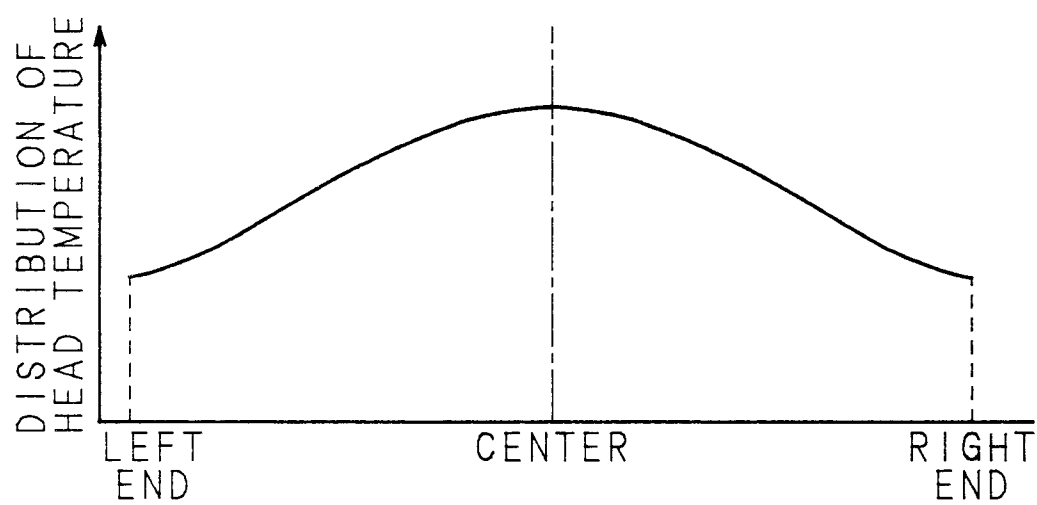


Fig. 17(a)

Prior Art

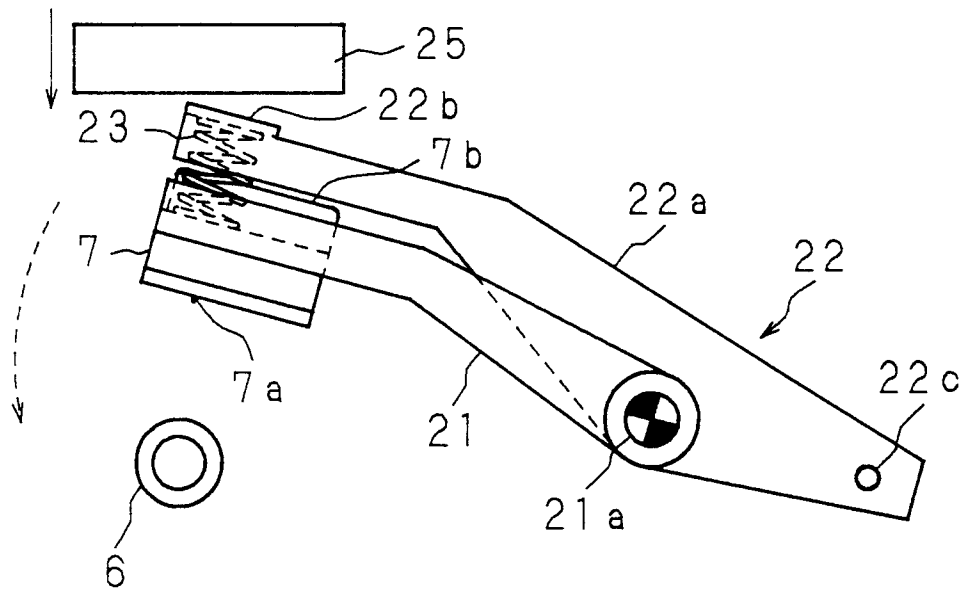


Fig. 17(b)

Prior Art

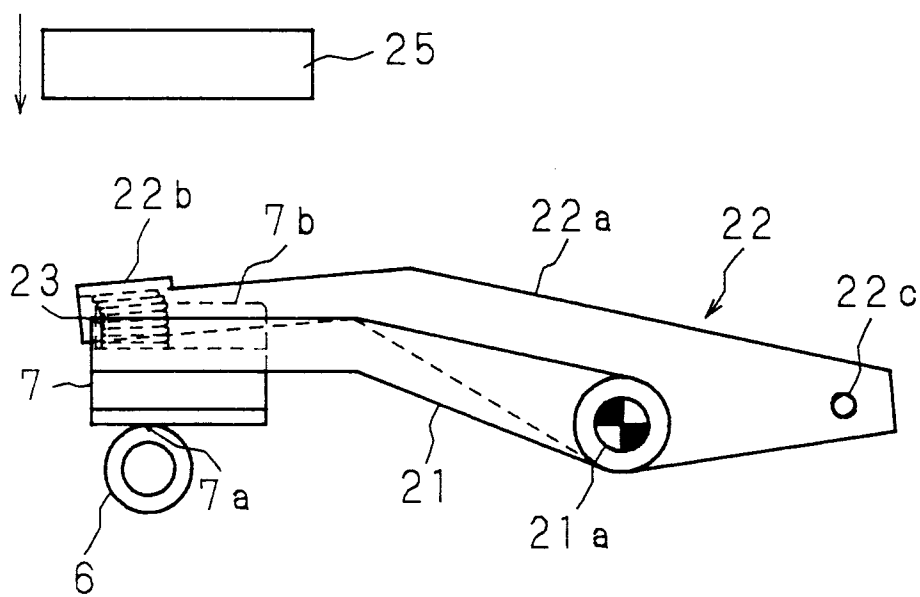


Fig. 18
Prior Art

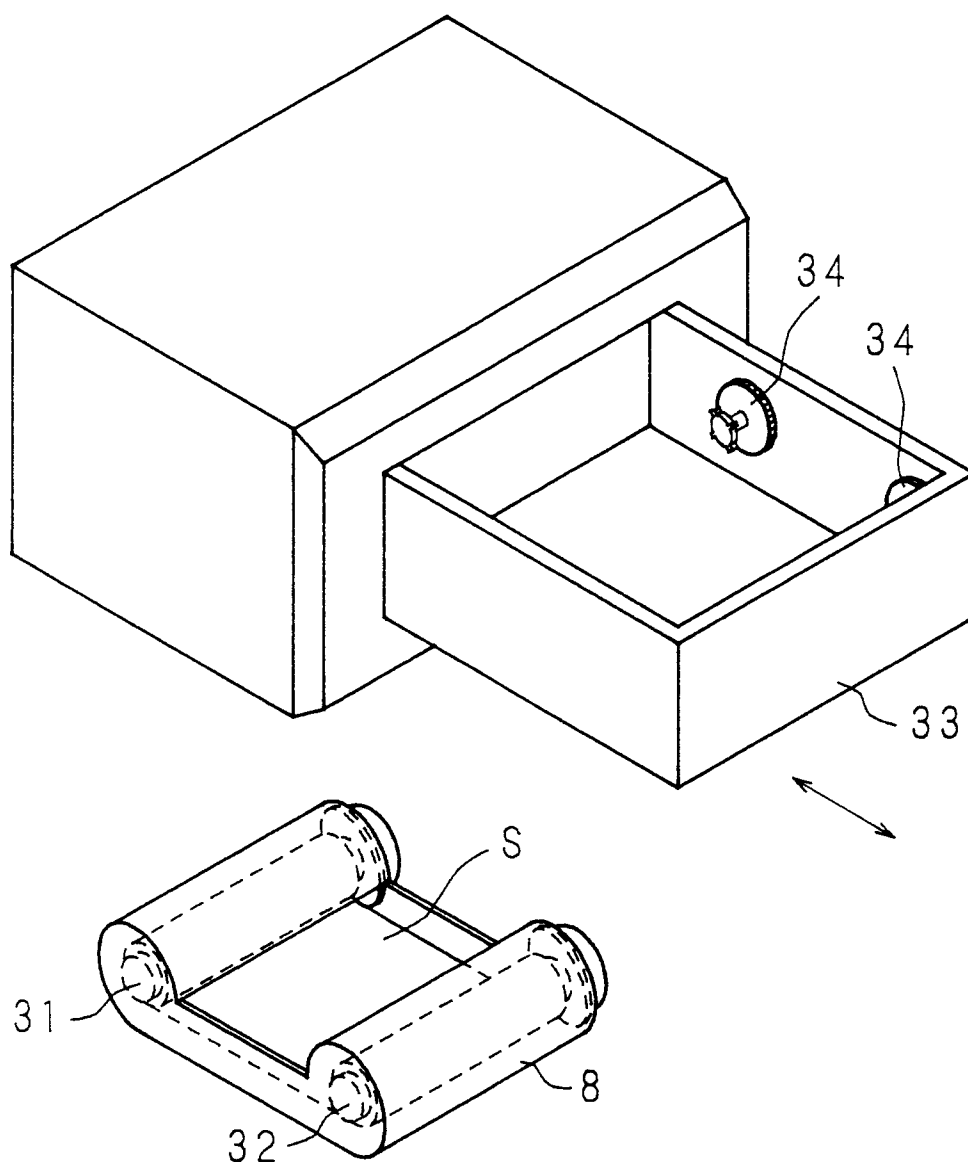


Fig. 19
Prior Art

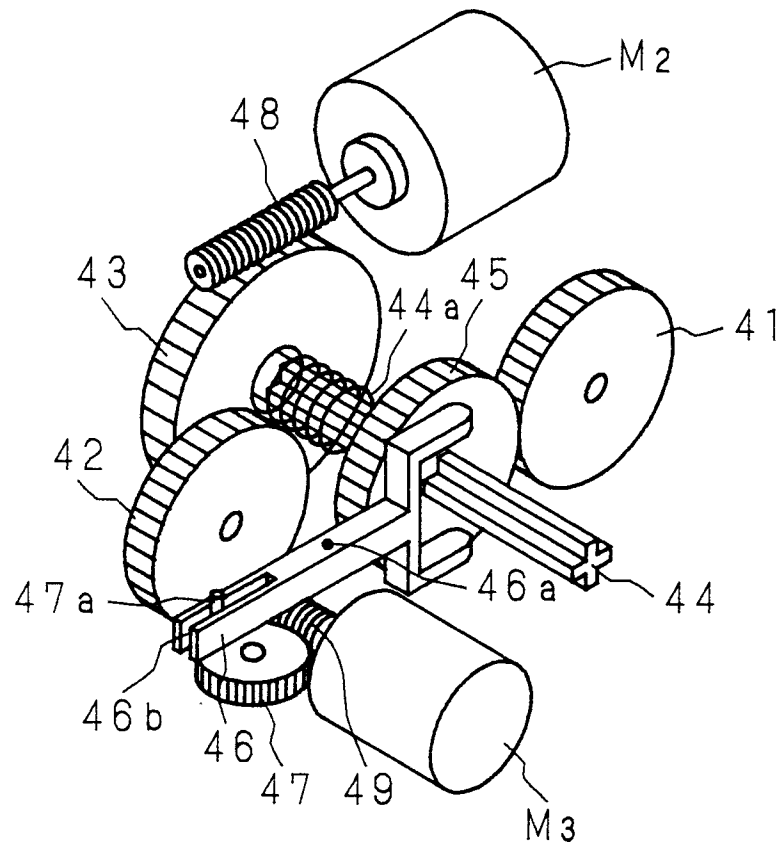


Fig. 20
Prior Art

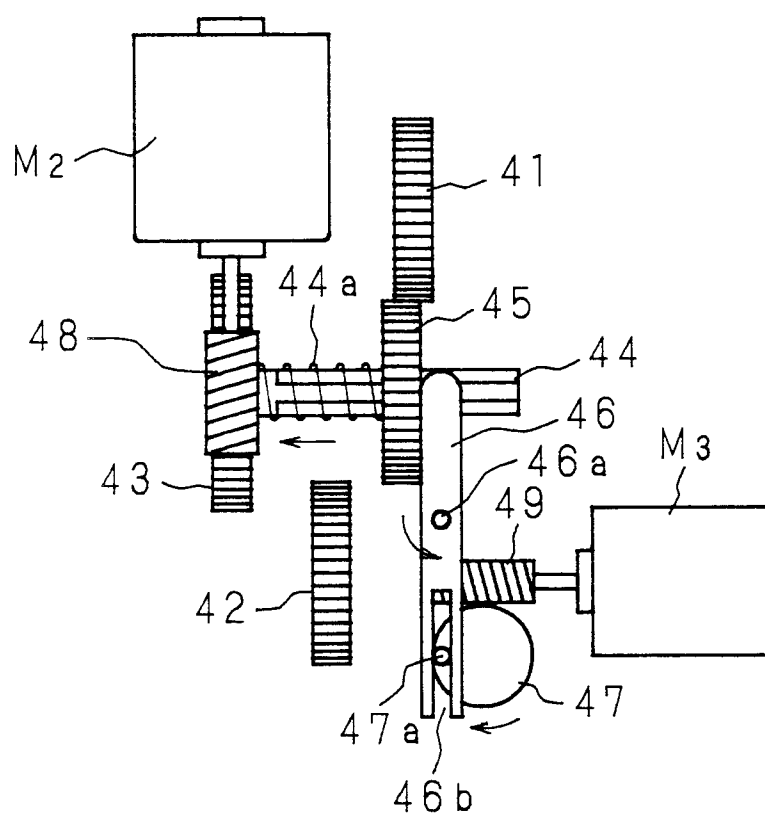


Fig. 21
Prior Art

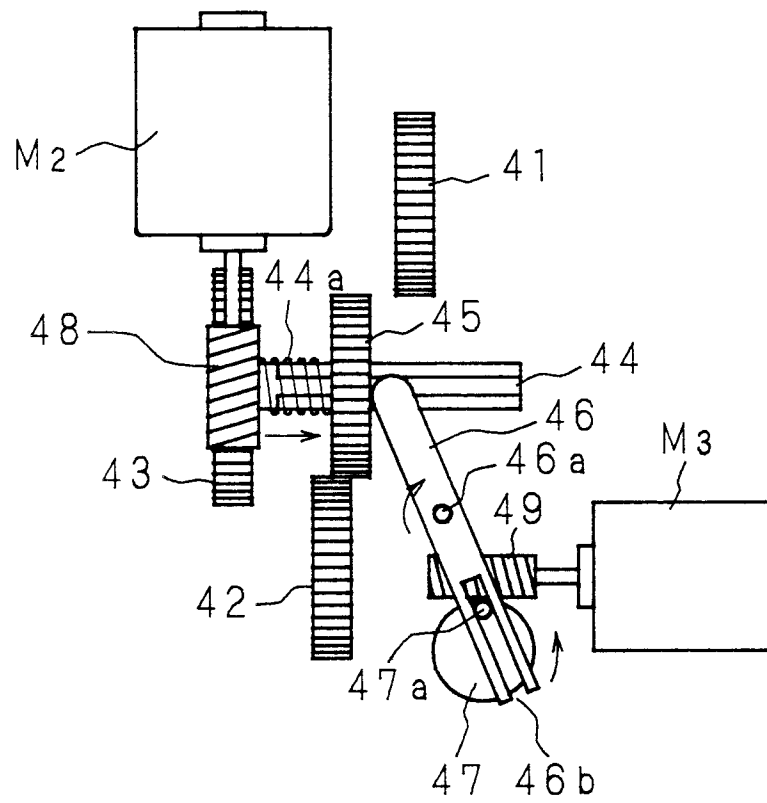
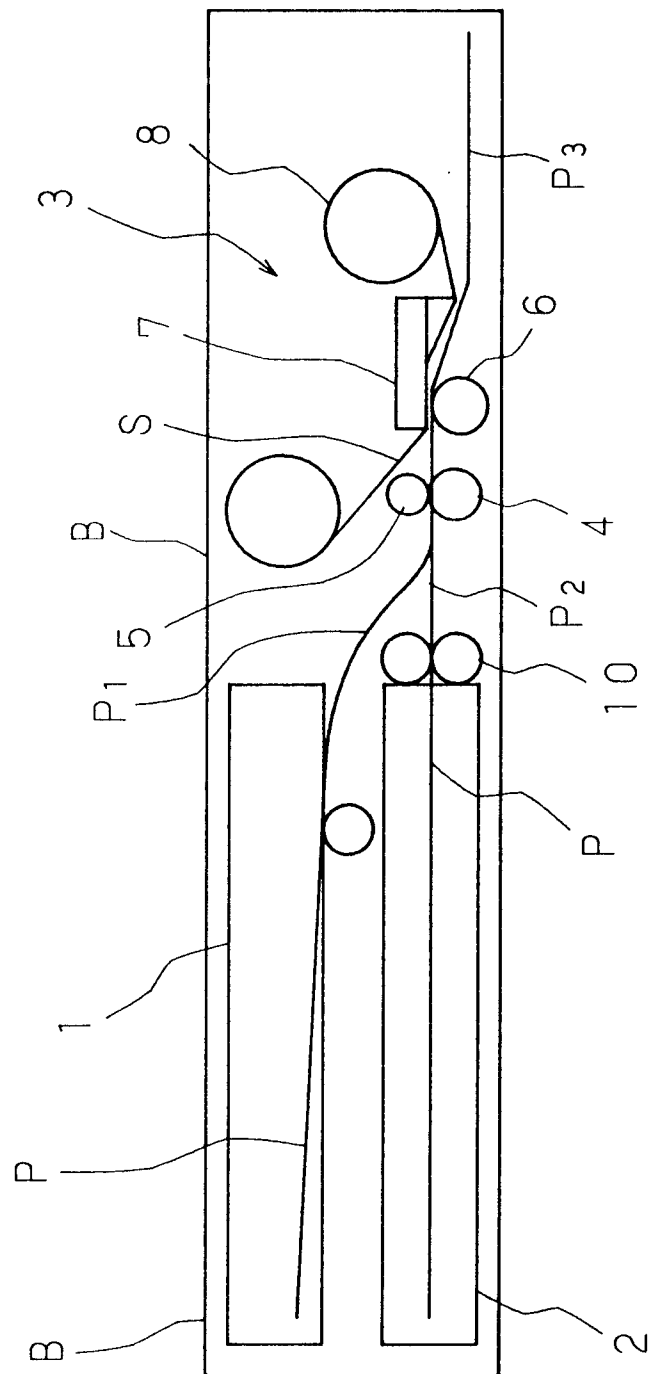


Fig. 22



F i g . 23

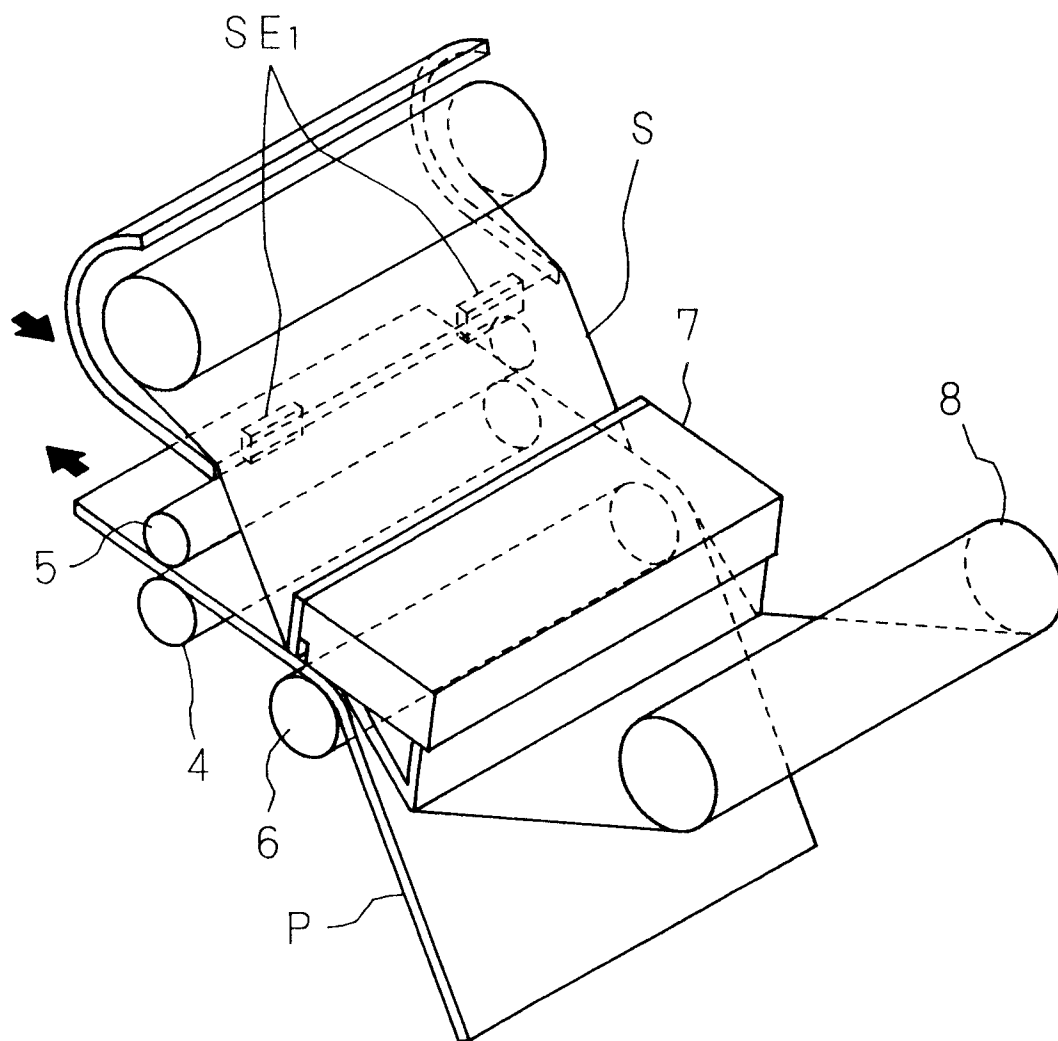


Fig. 25(a)

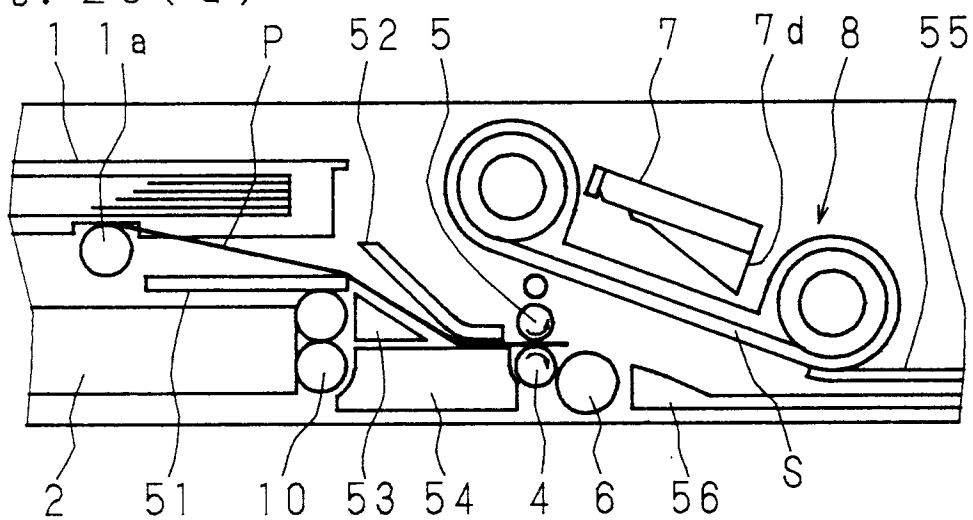


Fig. 25(b)

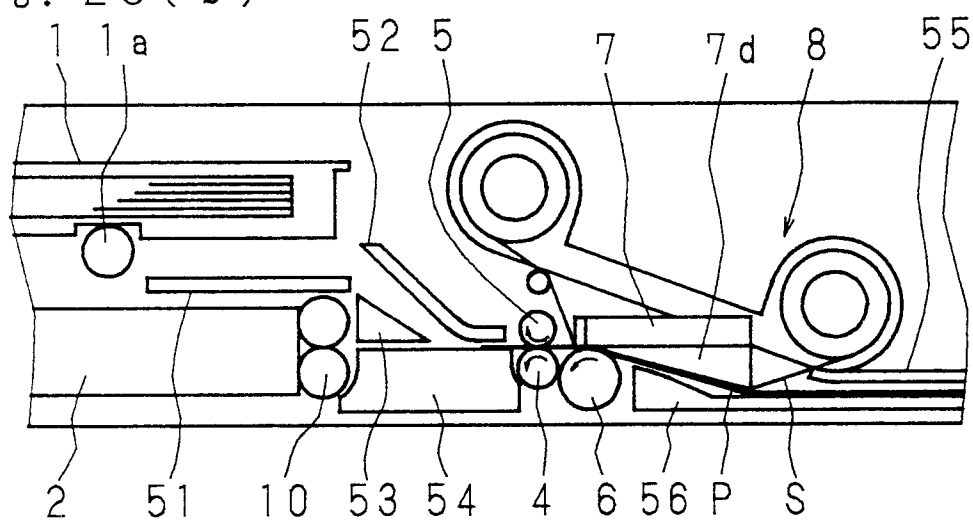


Fig. 25(c)

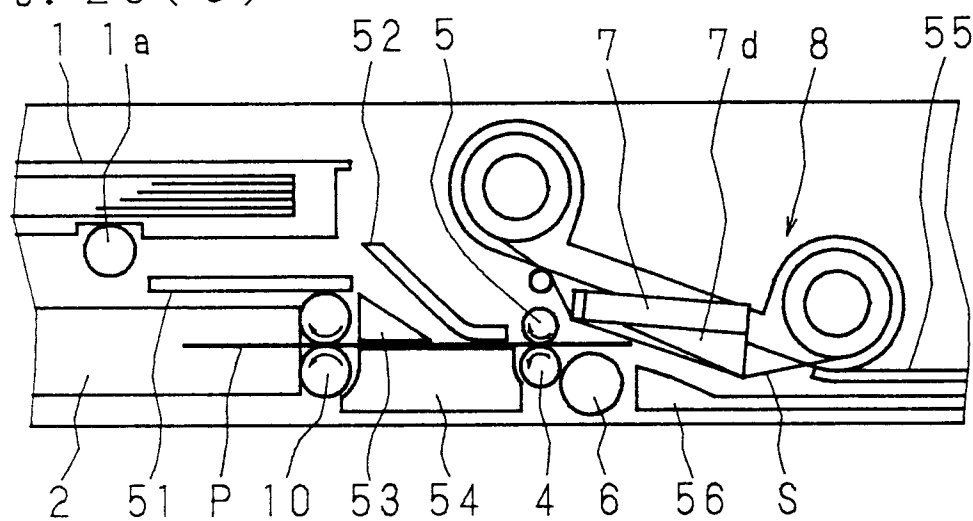


Fig. 26

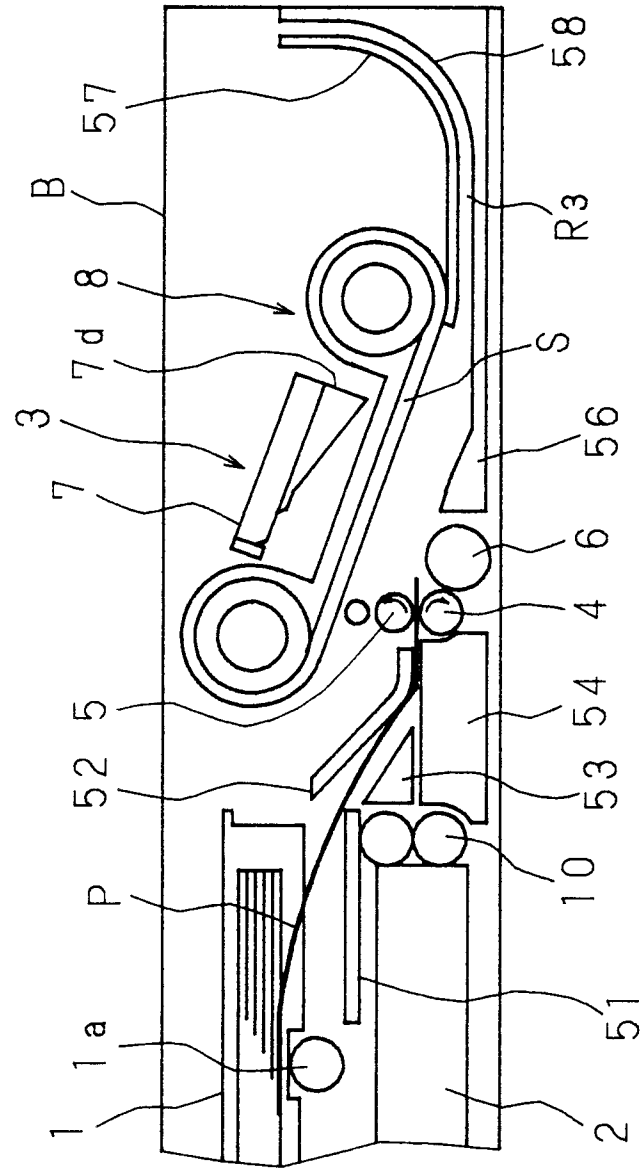


Fig. 27

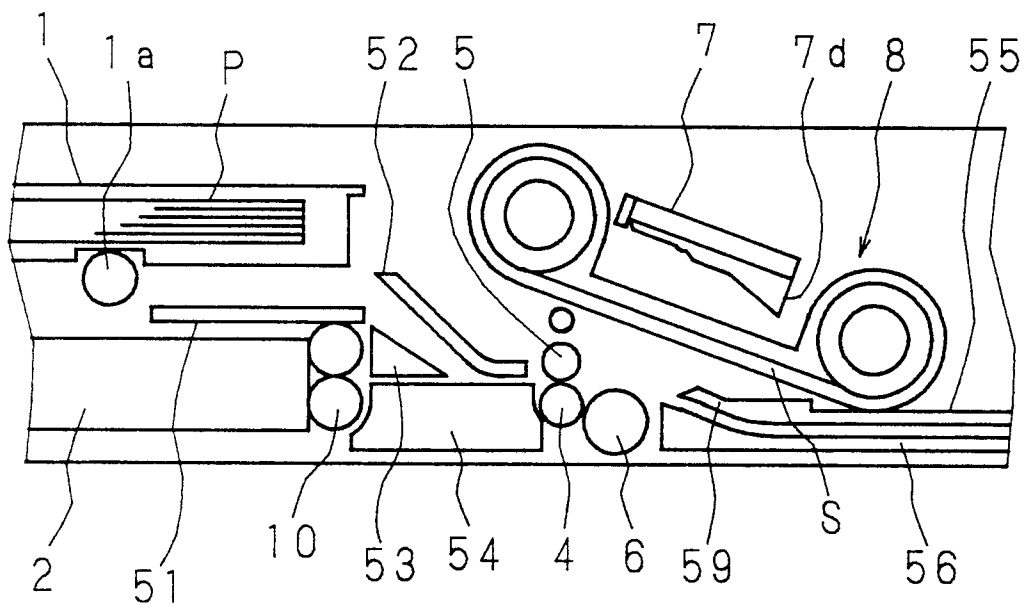


Fig. 28

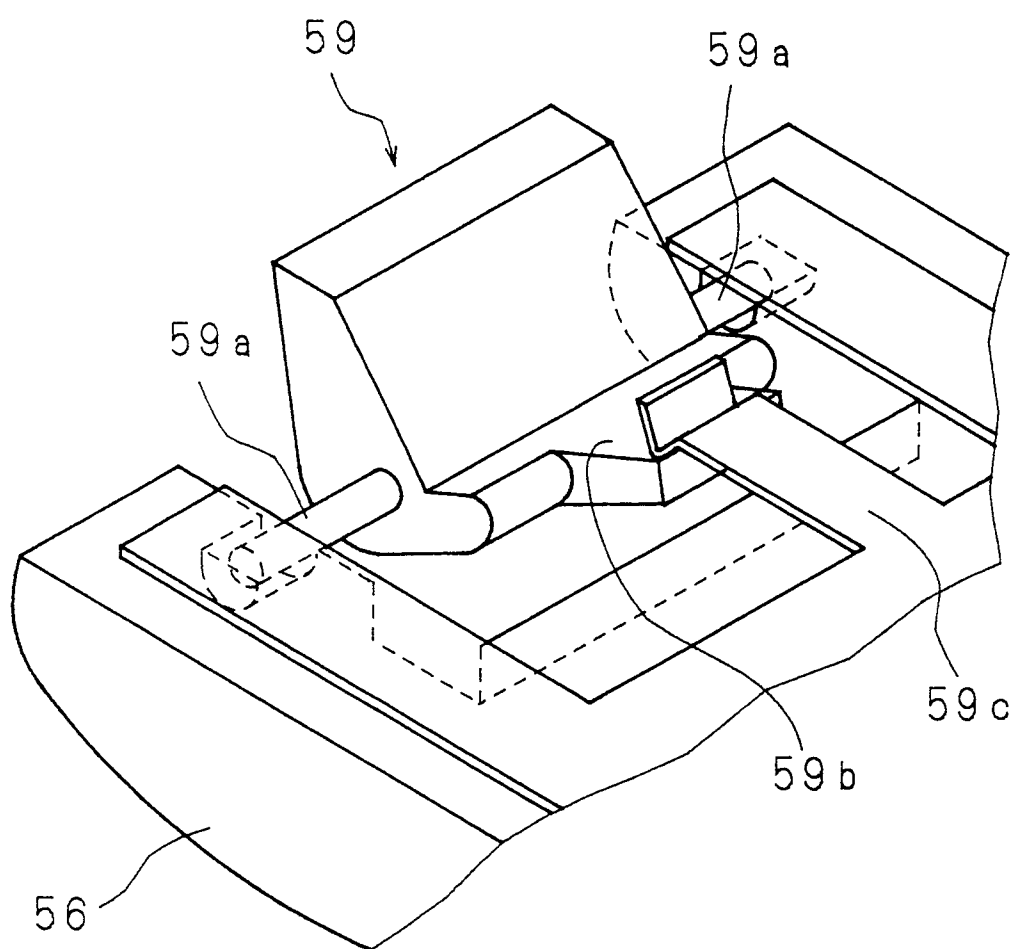


Fig. 29

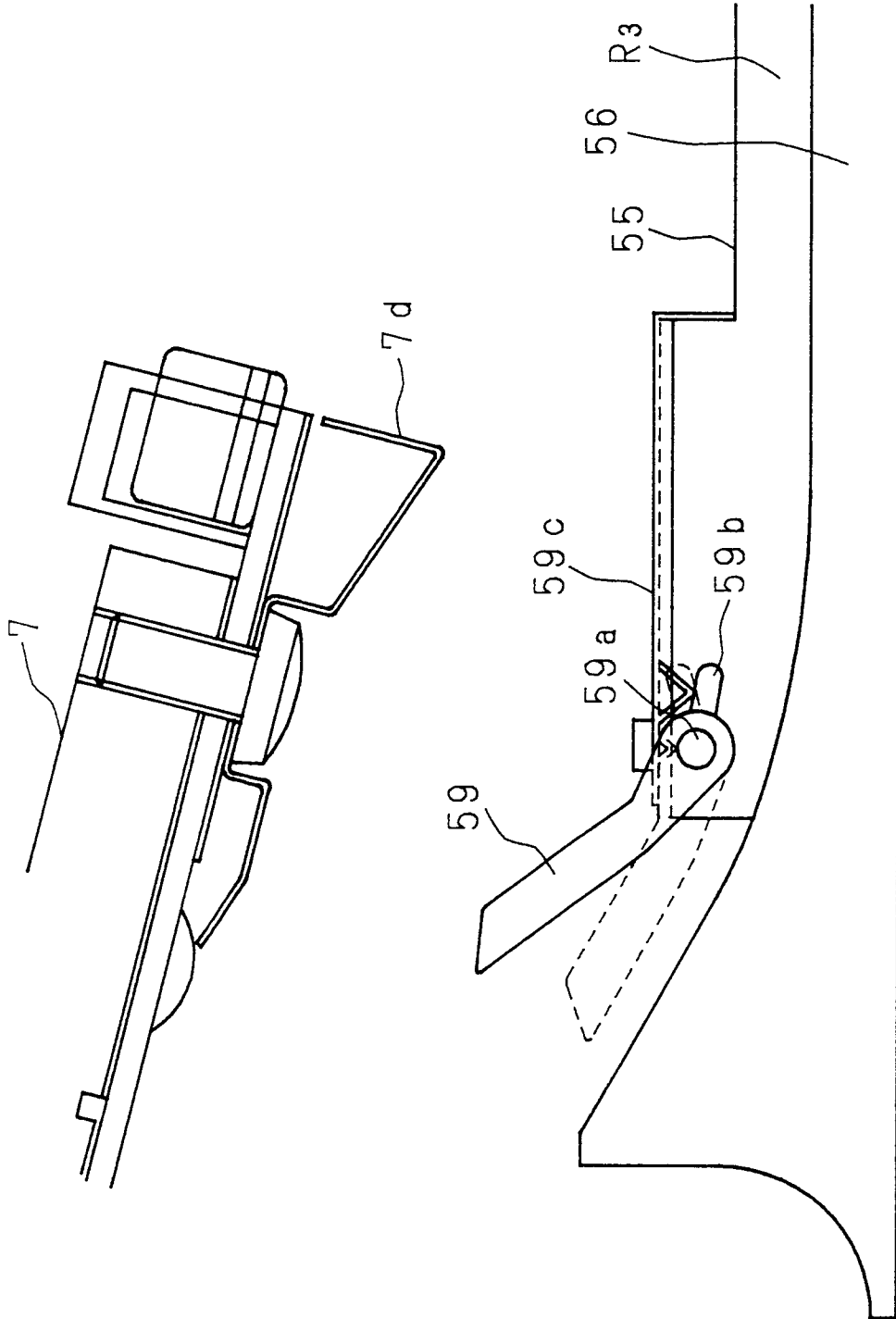


Fig. 30

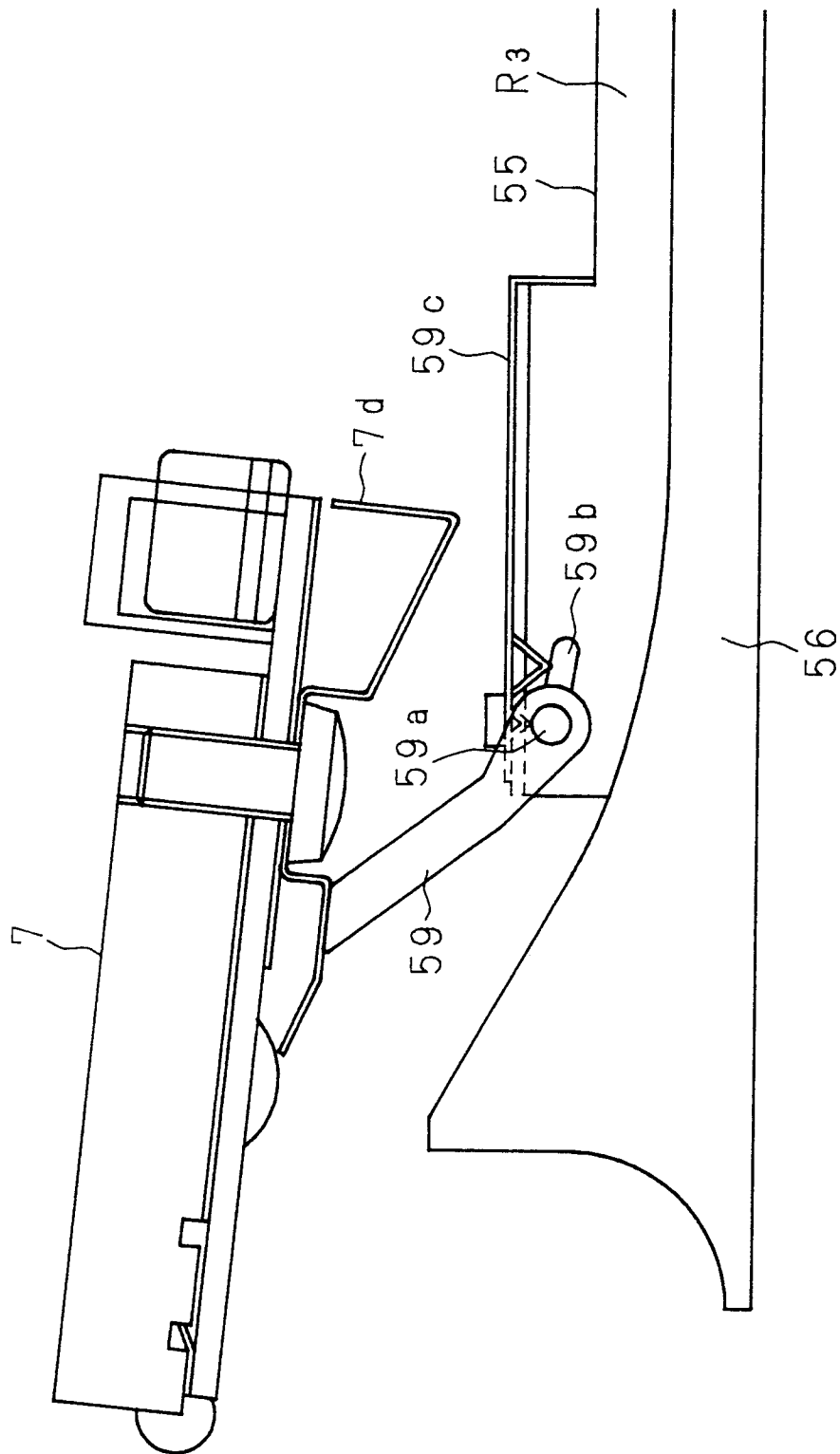


Fig. 31

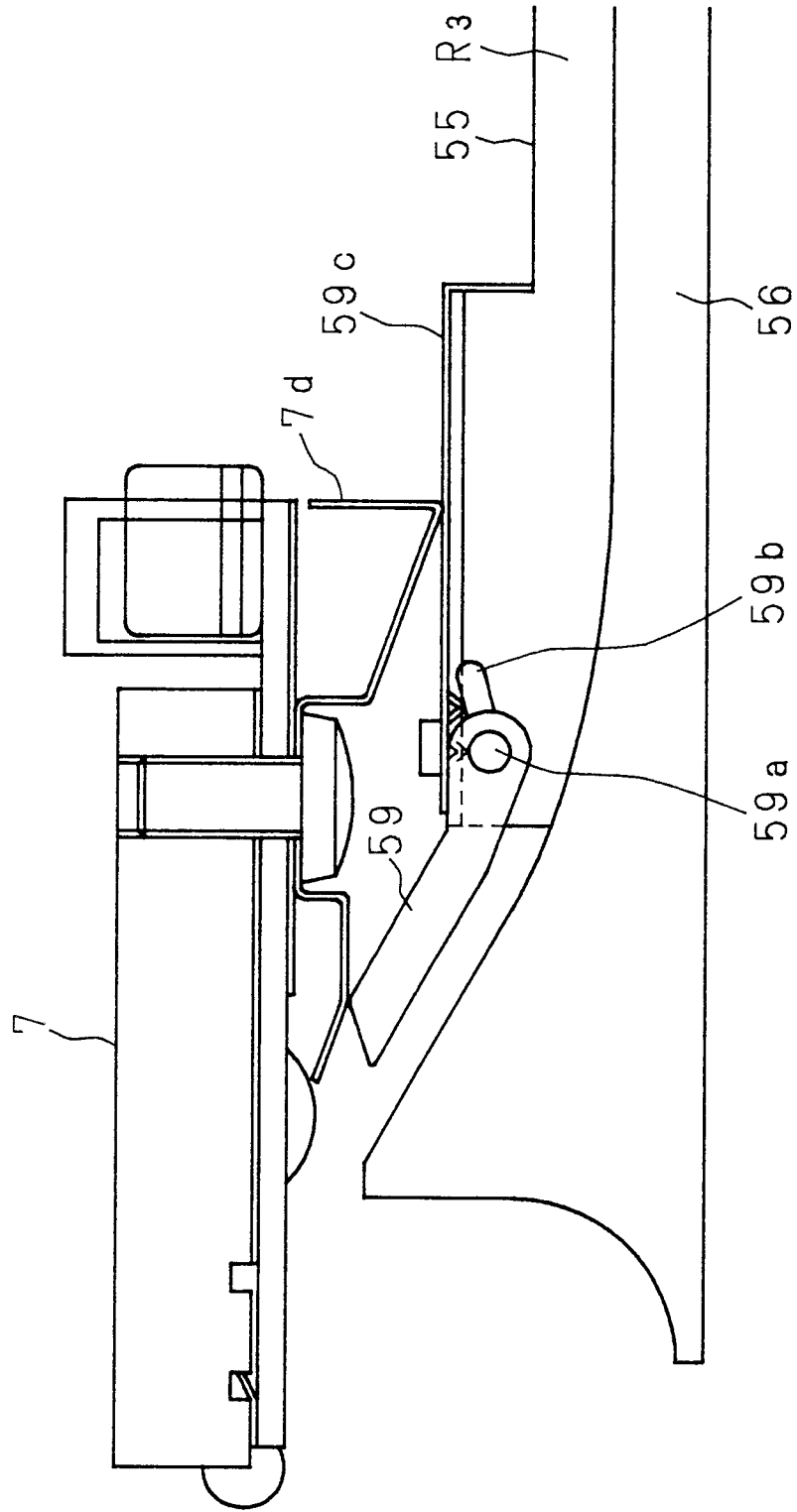


Fig. 32

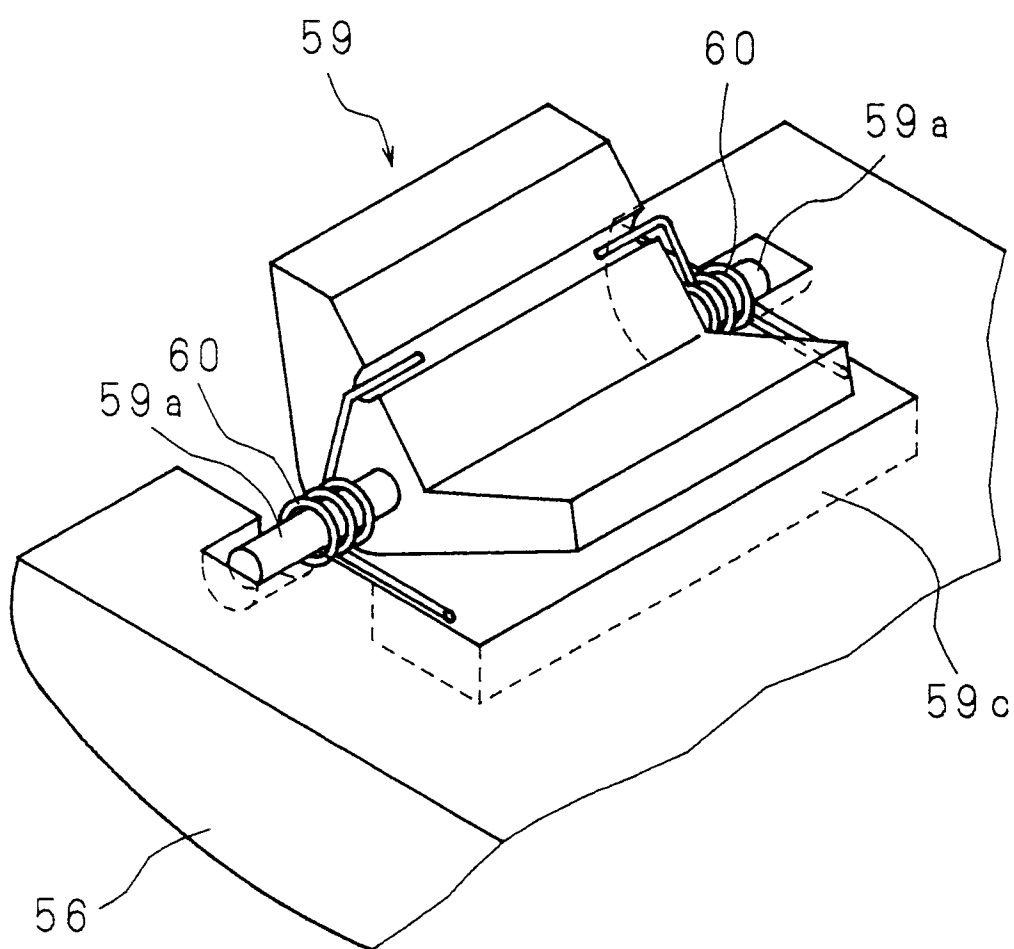


Fig. 33

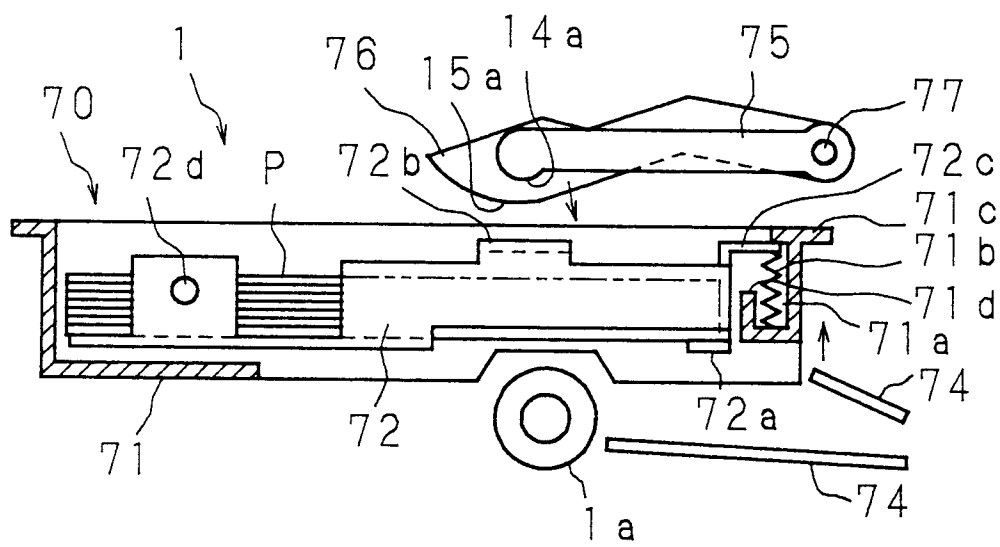
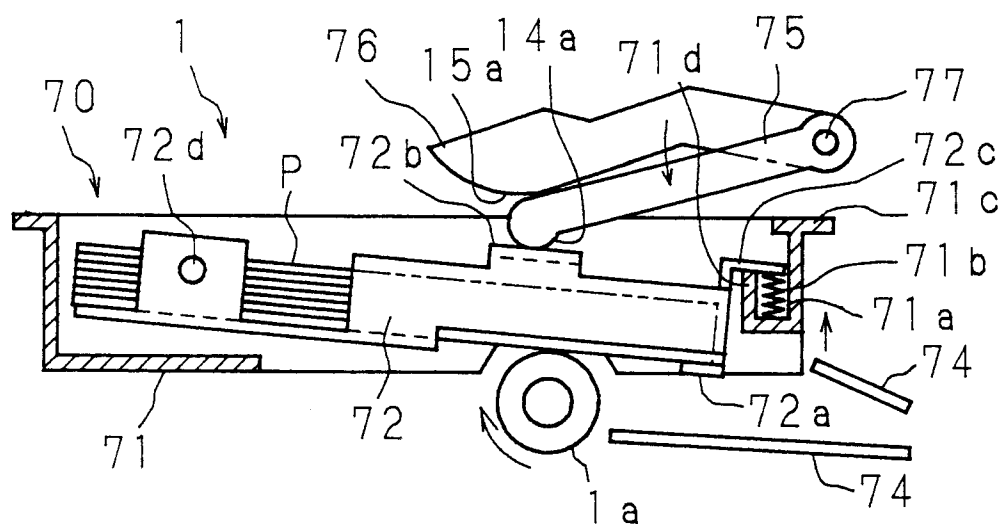


Fig. 34 (a)



F i g . 3 4 (b)

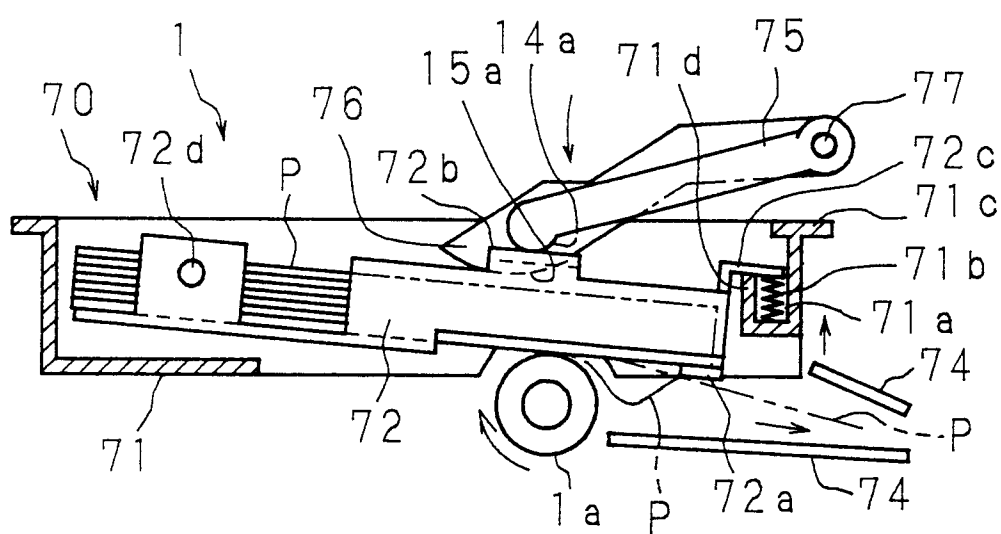


Fig. 35

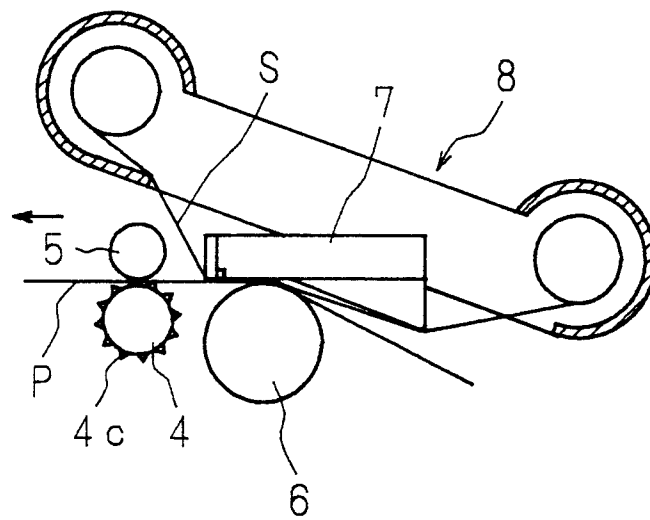


Fig. 36

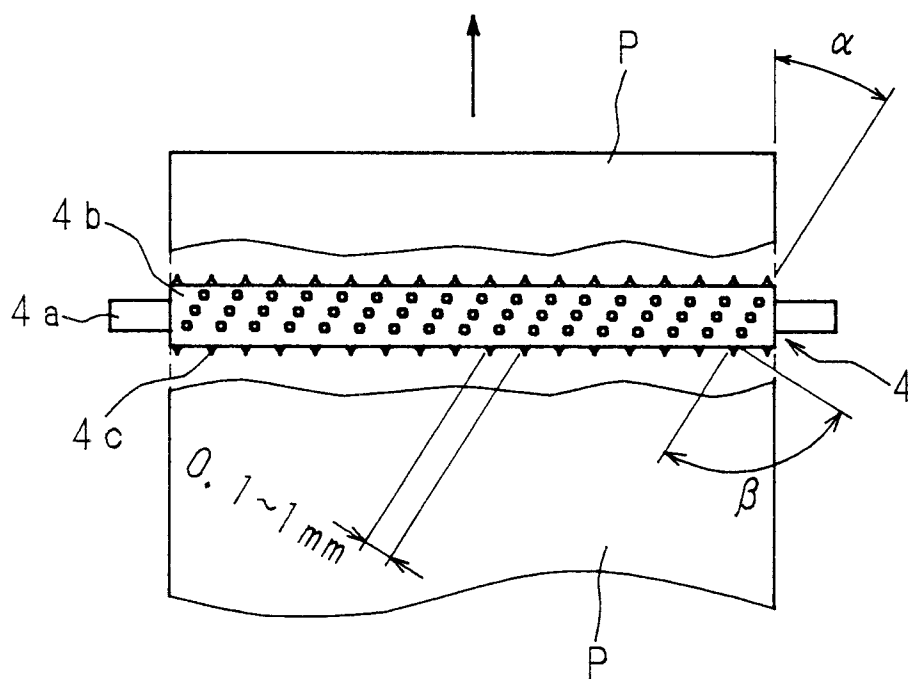


Fig. 37

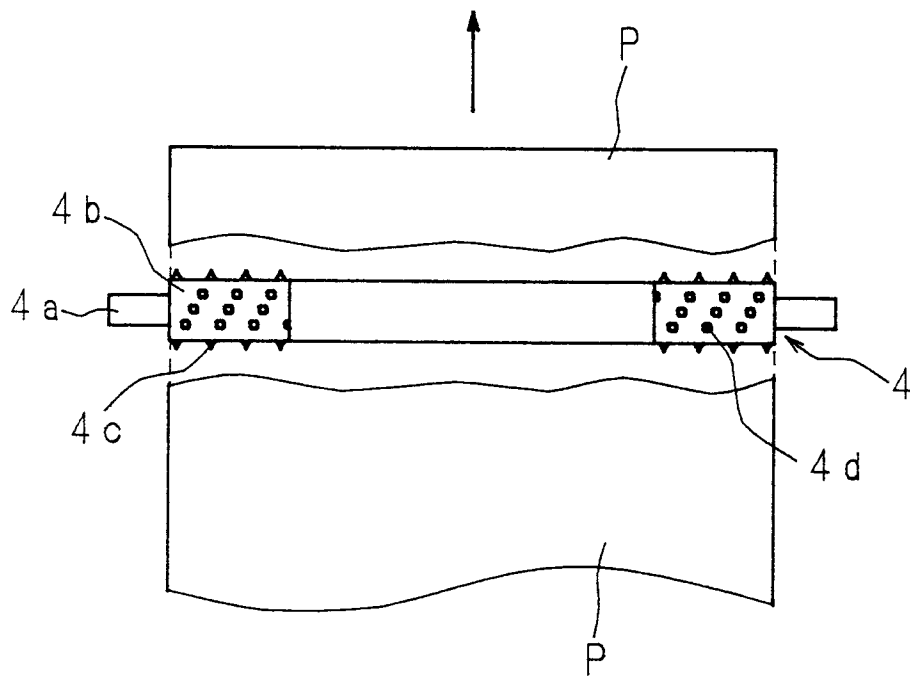


Fig. 38

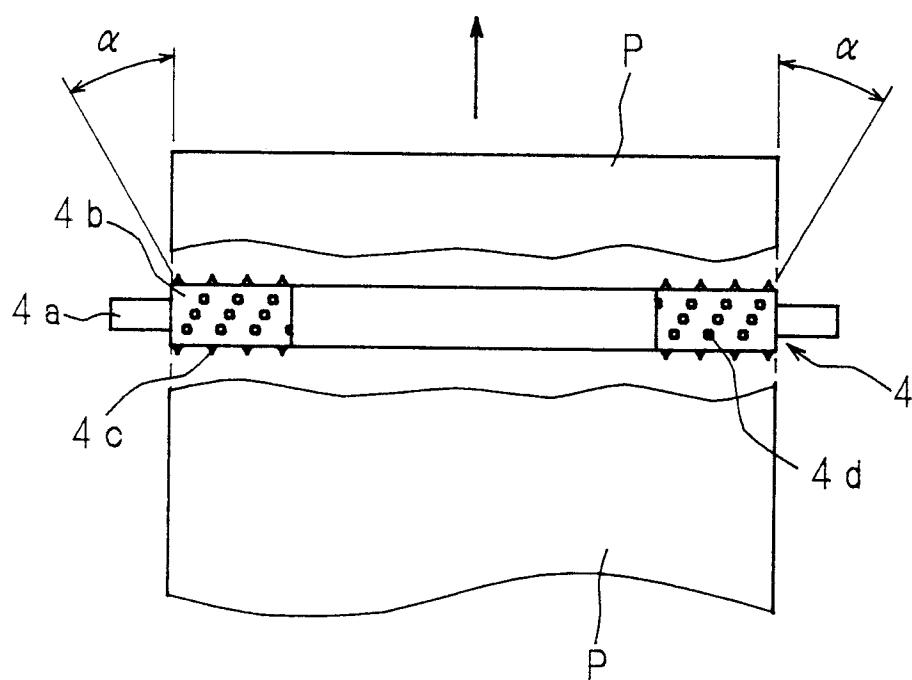
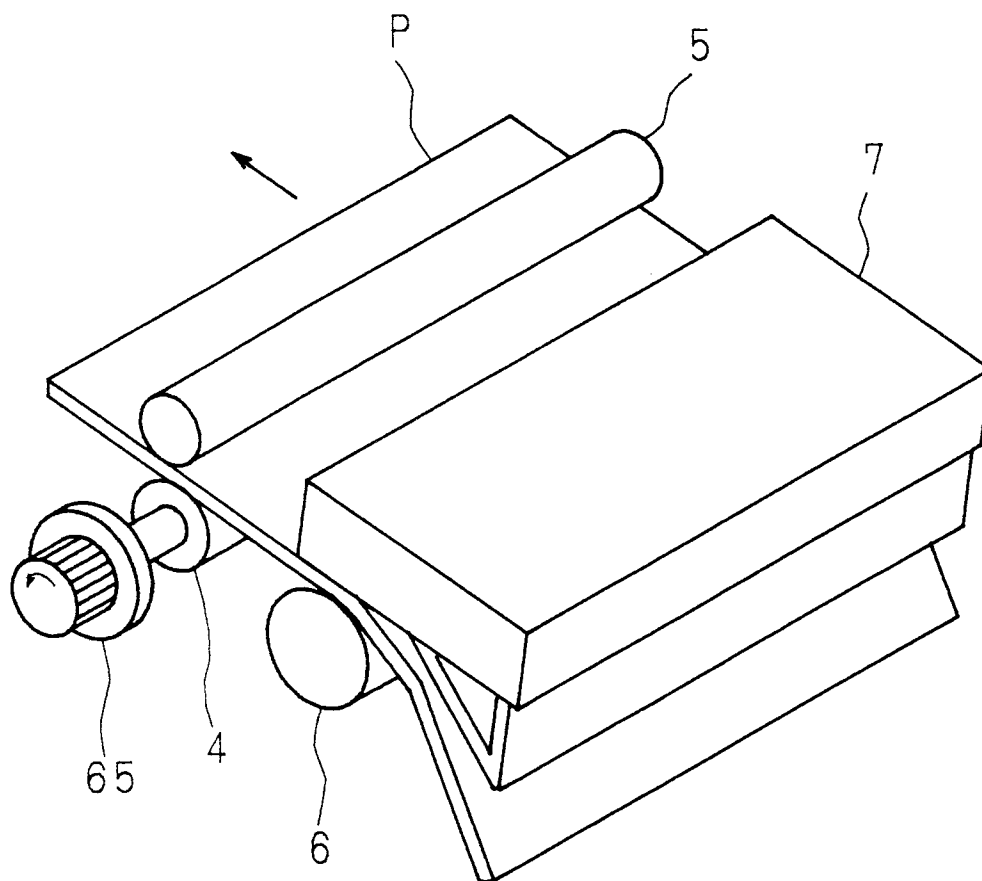
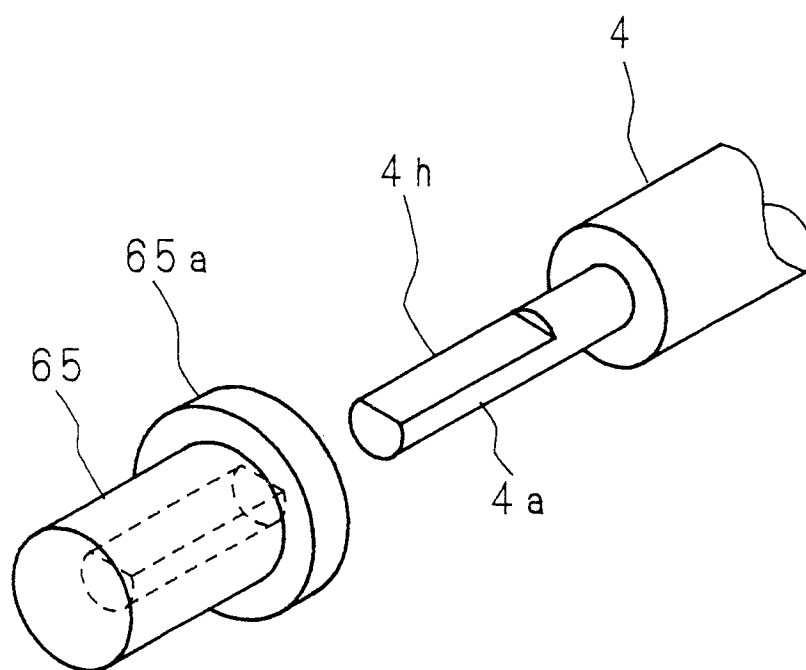


Fig. 39



F i g . 4 0



F i g . 4 1

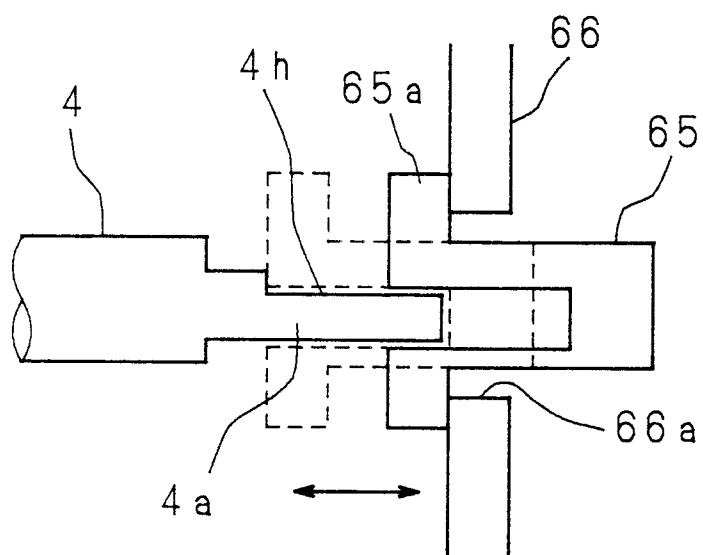


Fig. 42

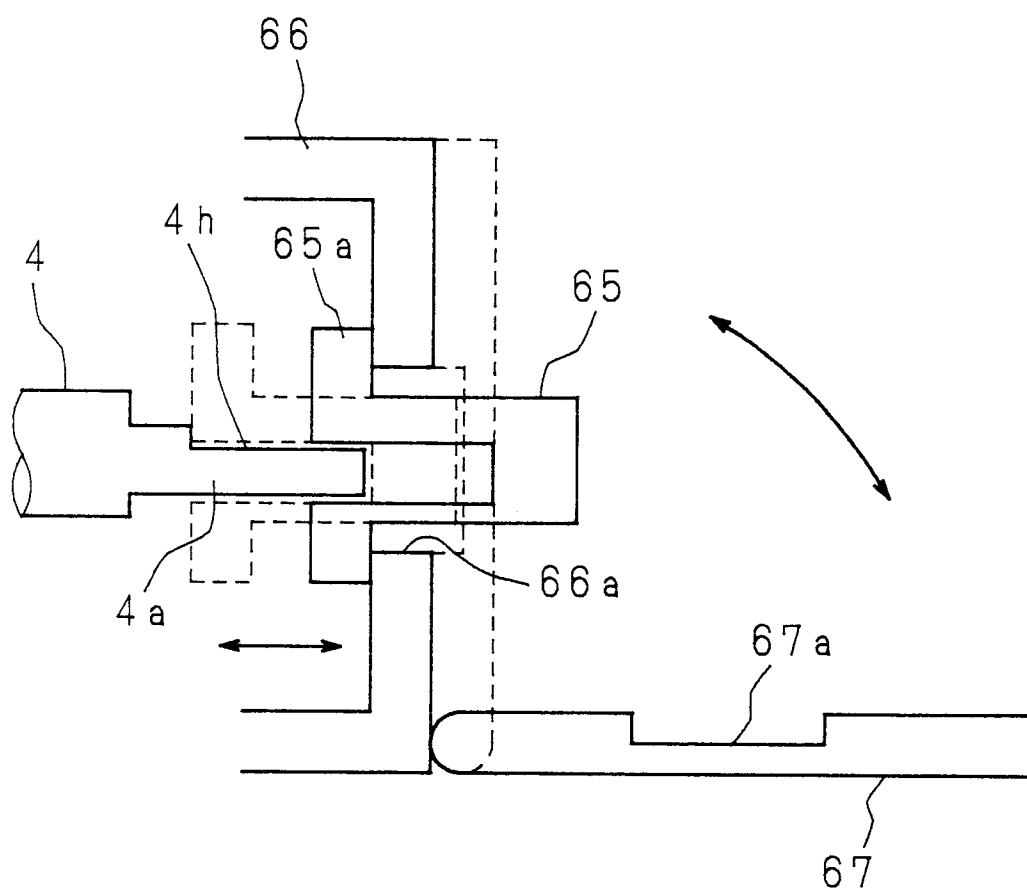


Fig. 43

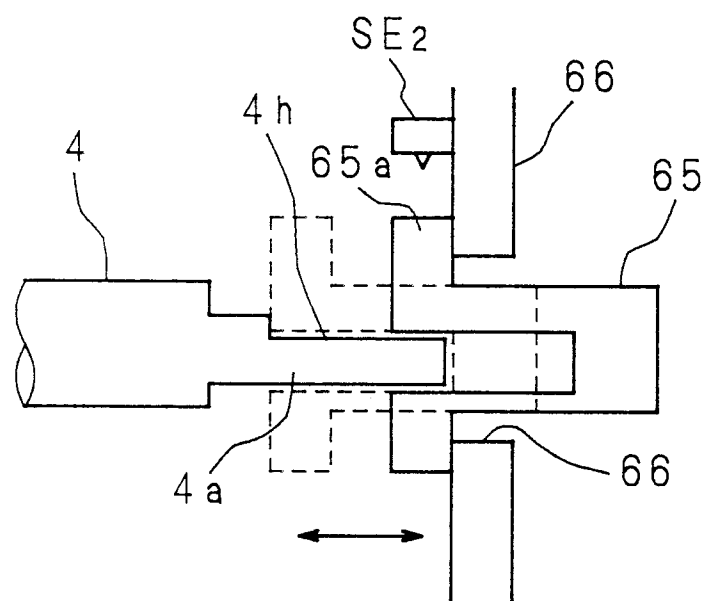


Fig. 44

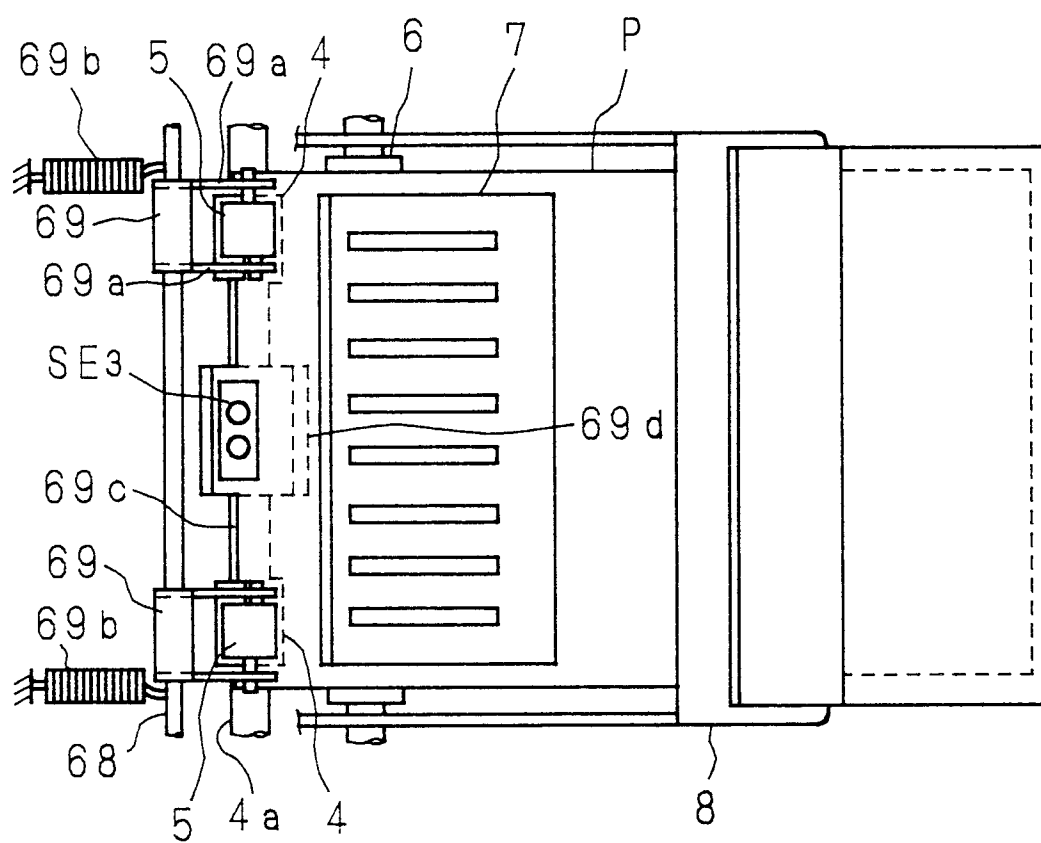


Fig. 45

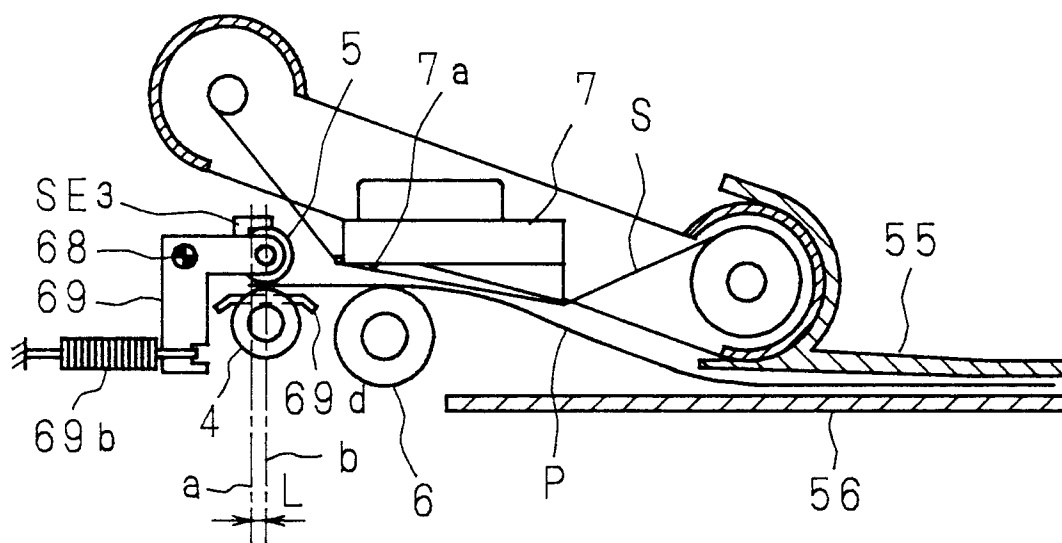


Fig. 46 (a)

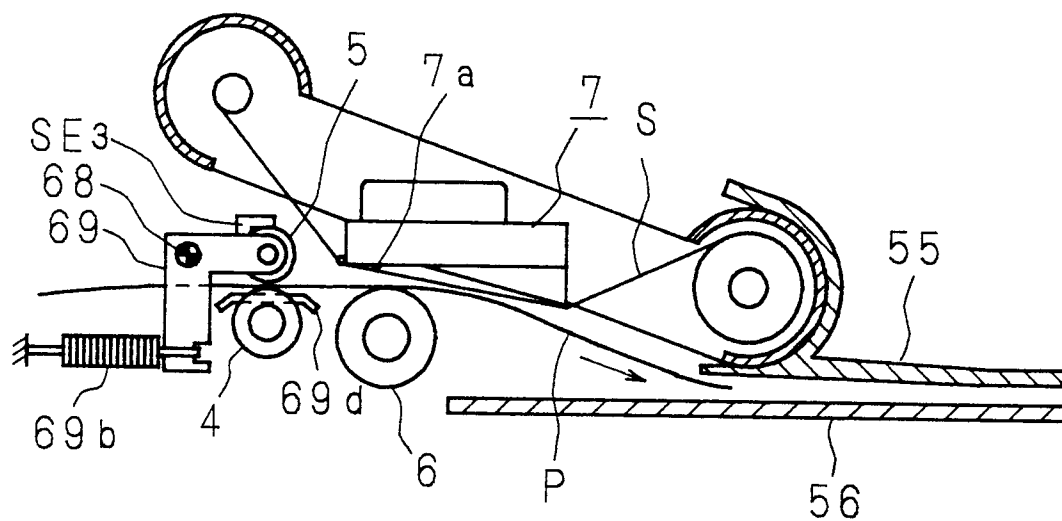


Fig. 46 (b)

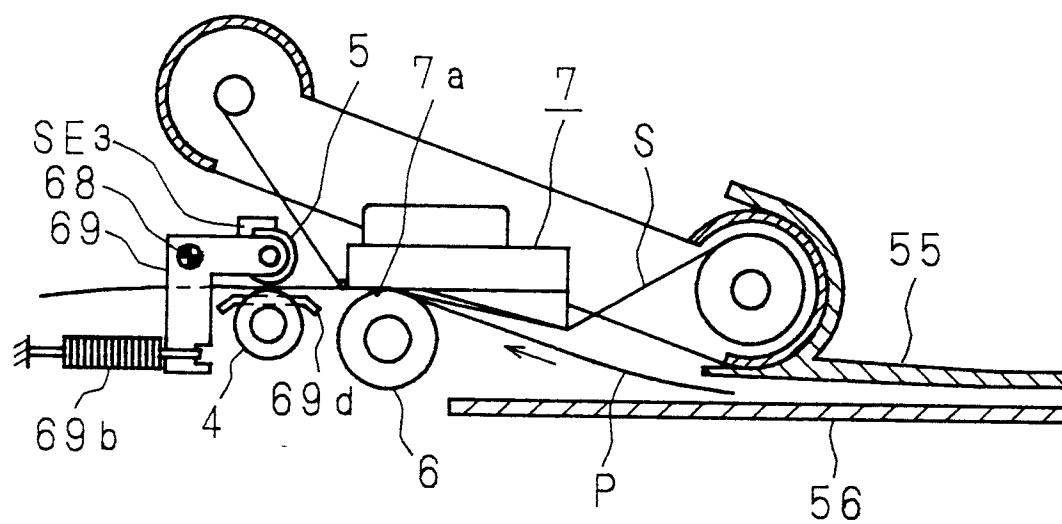


Fig. 47

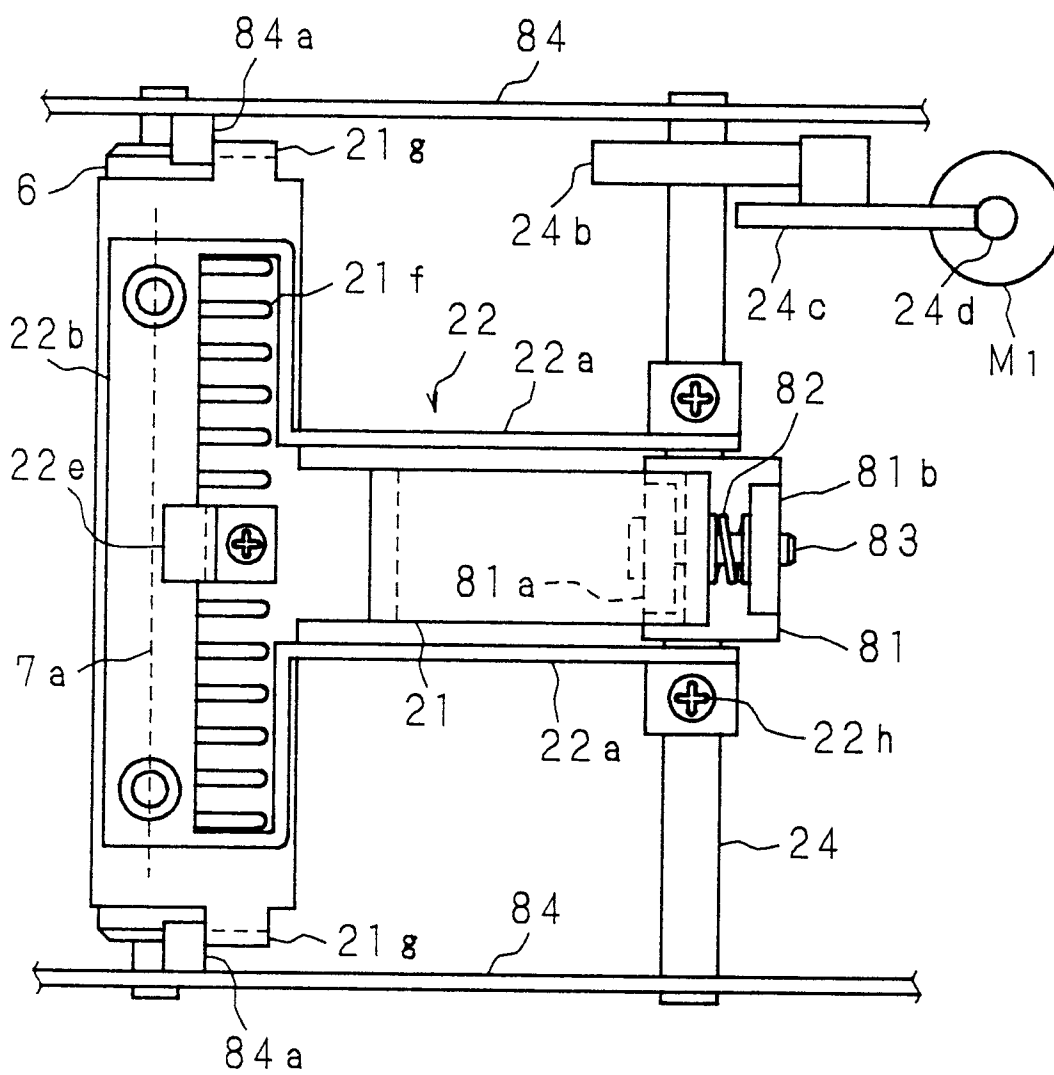


Fig. 48

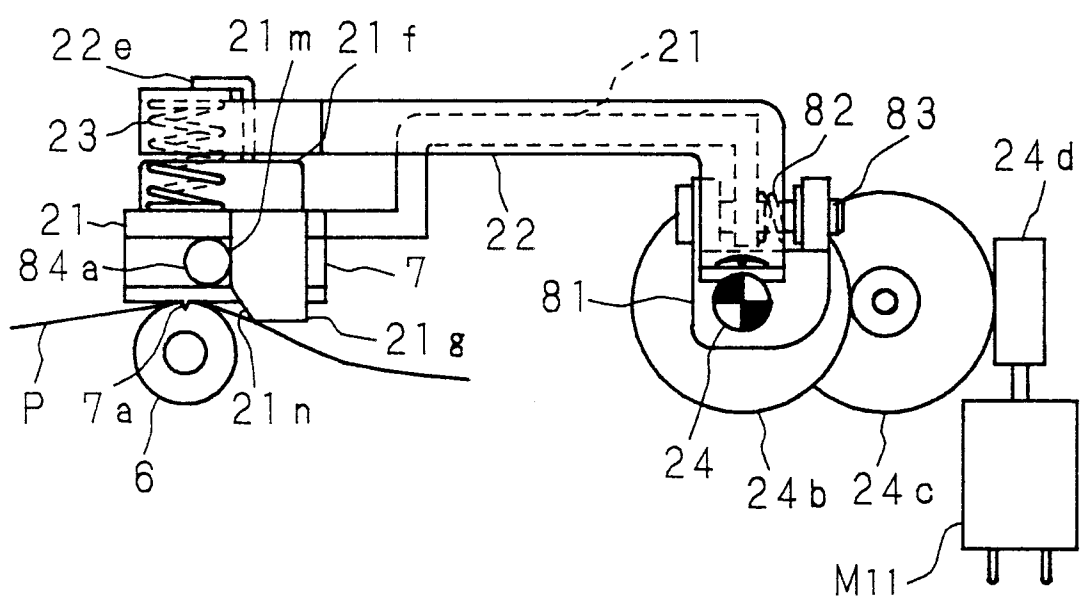


Fig. 49

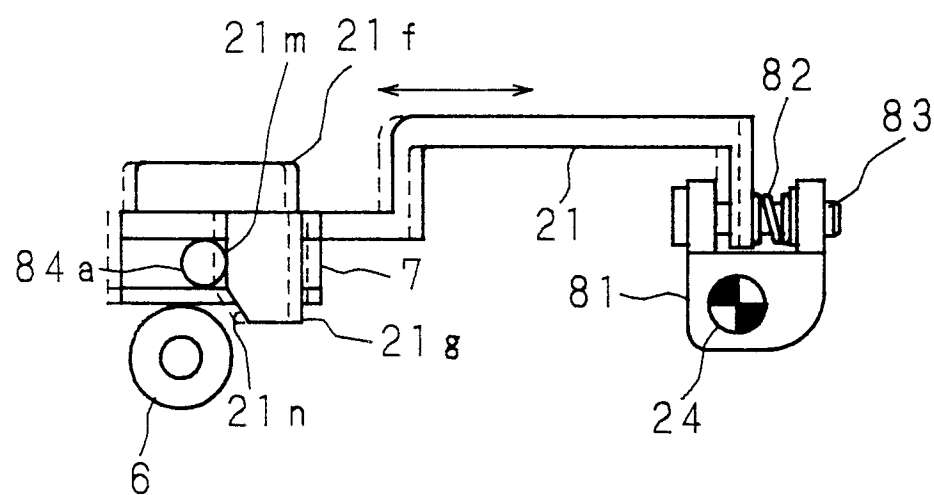


Fig. 50(a)

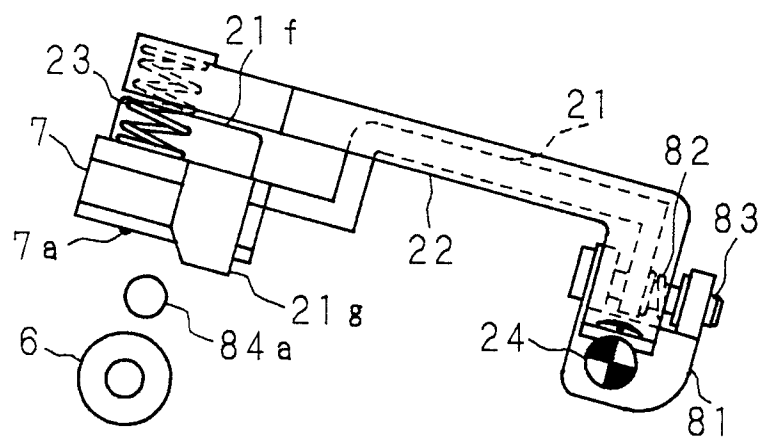


Fig. 50(b)

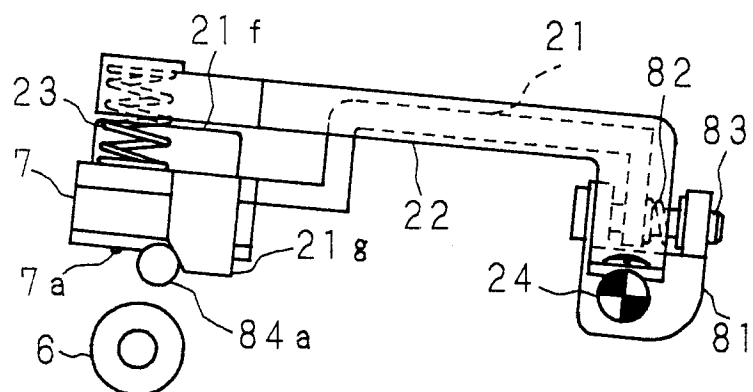
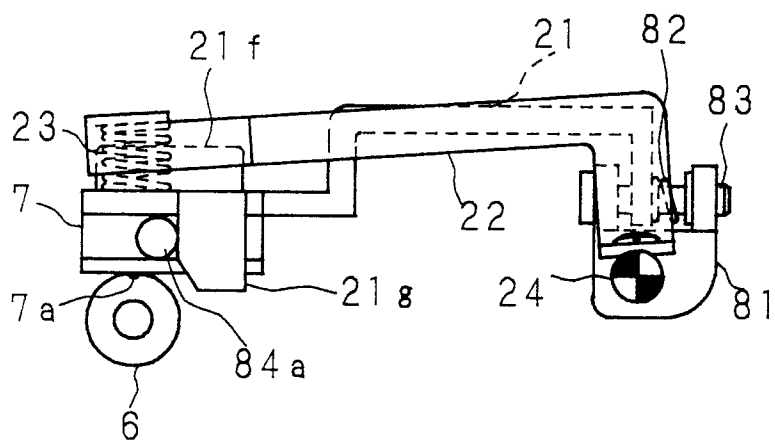


Fig. 50(c)



F i g . 5 1

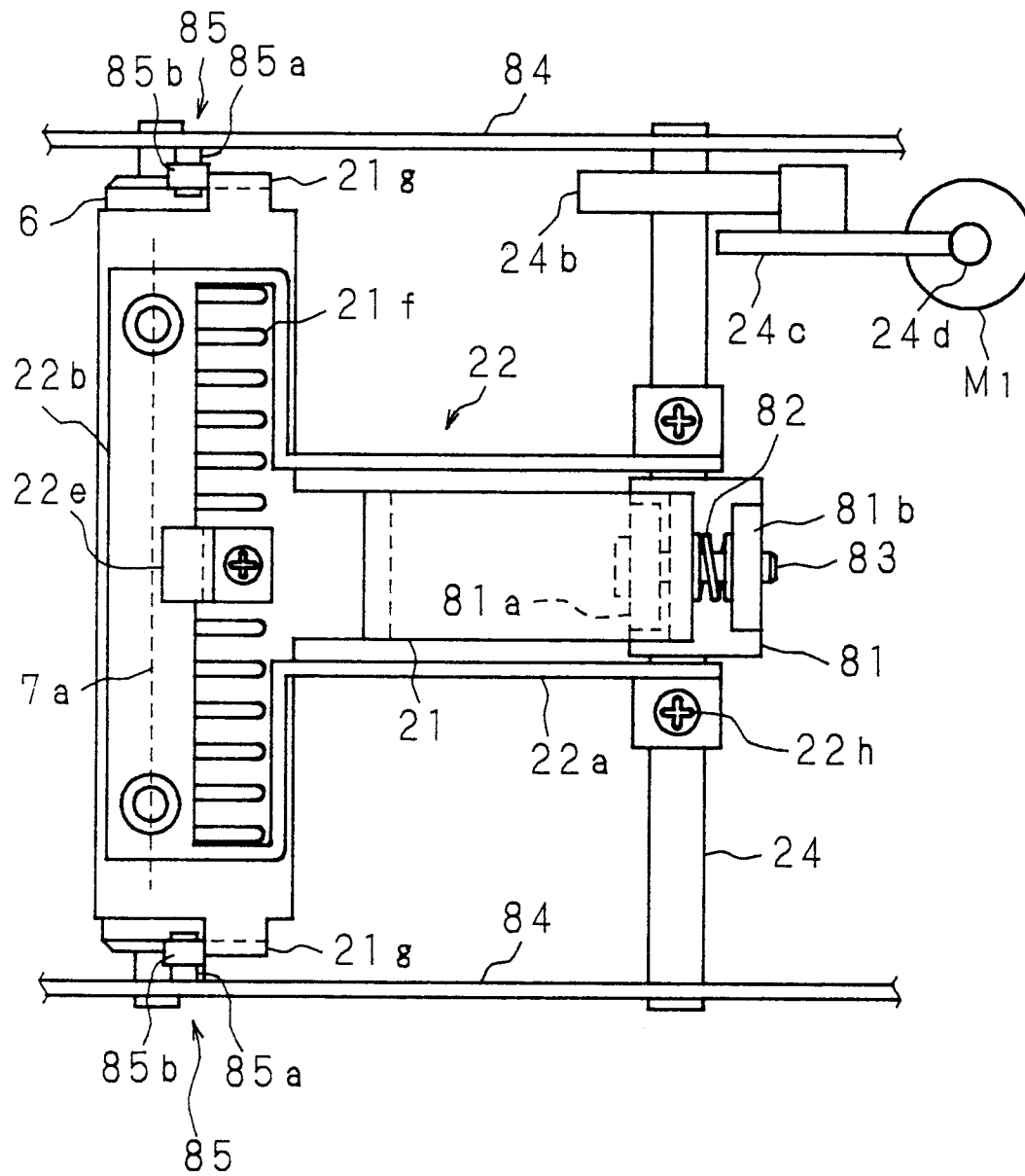


Fig. 52

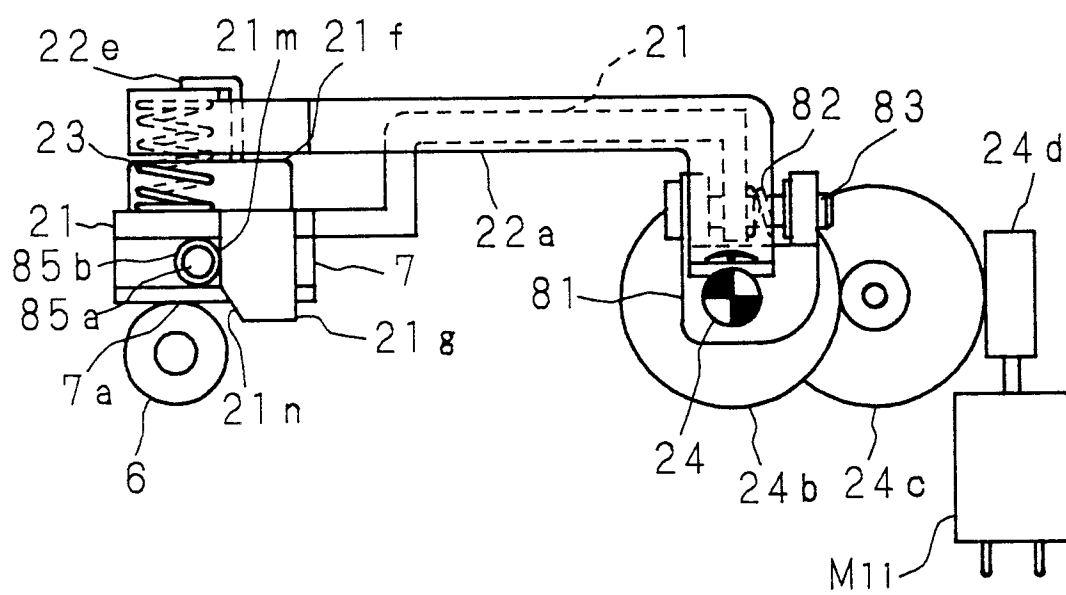


Fig. 53

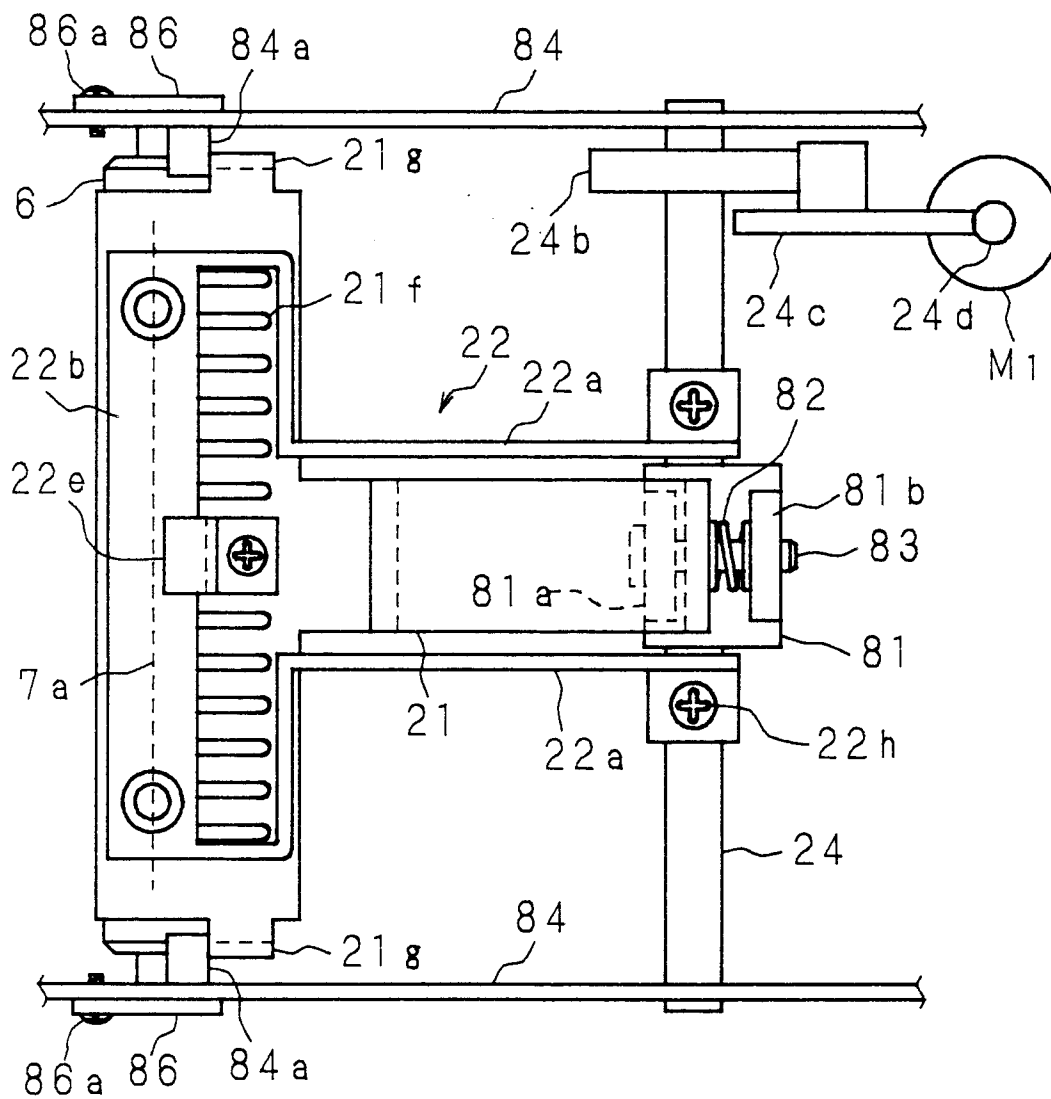


Fig. 54

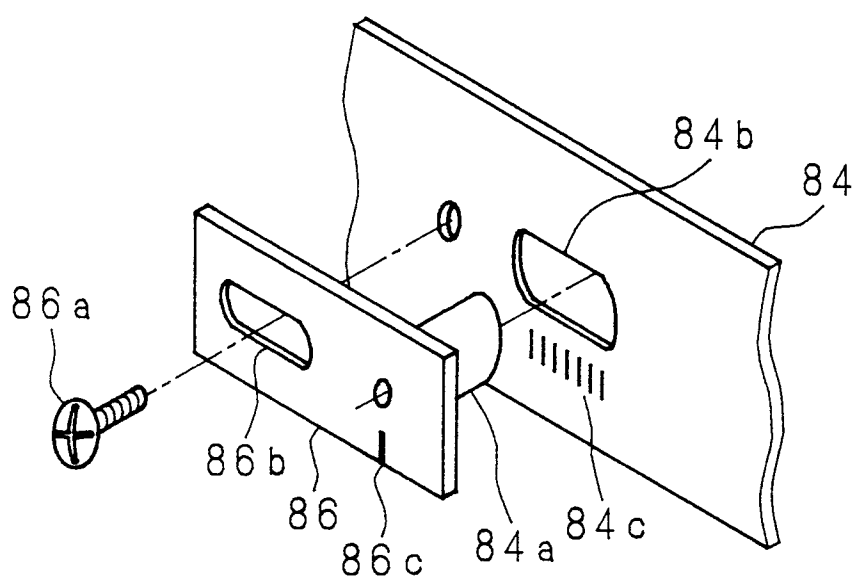


Fig. 55

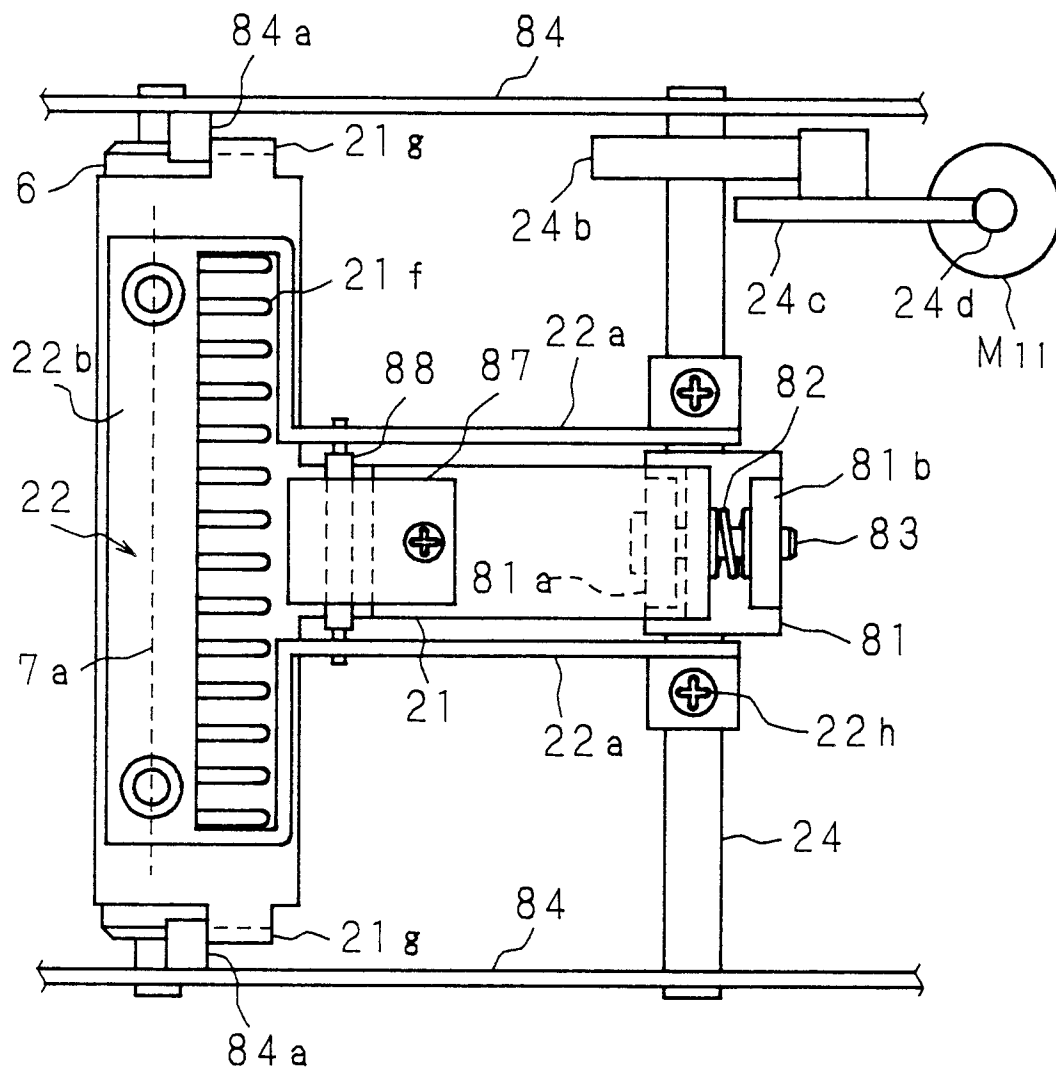


Fig. 56

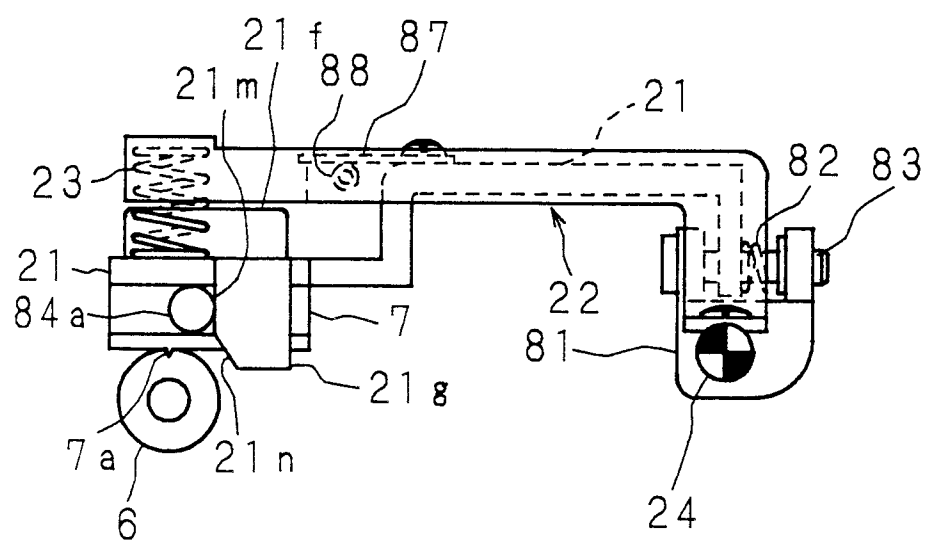


Fig. 57

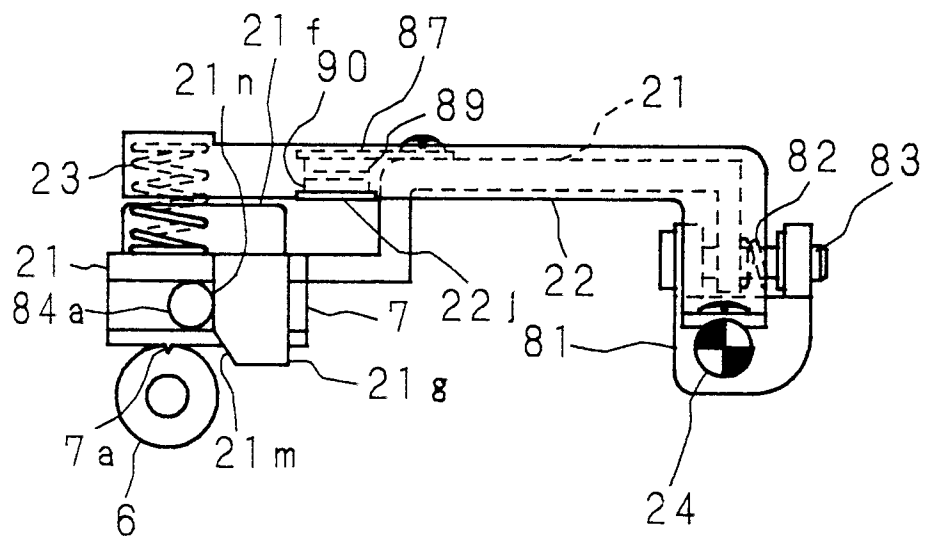


Fig. 58

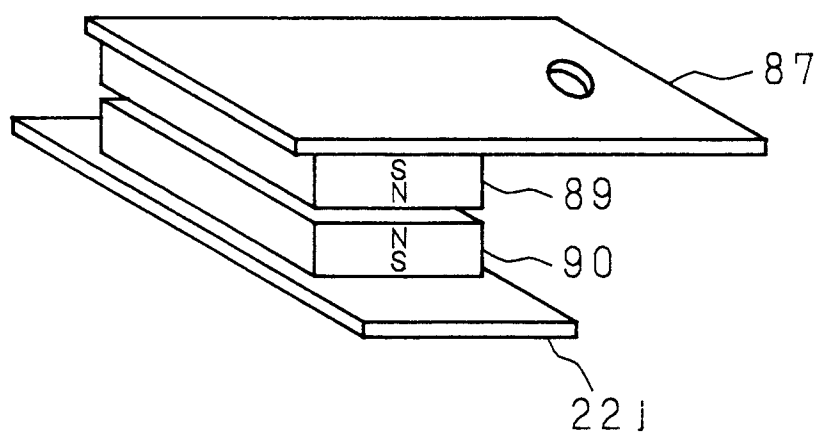
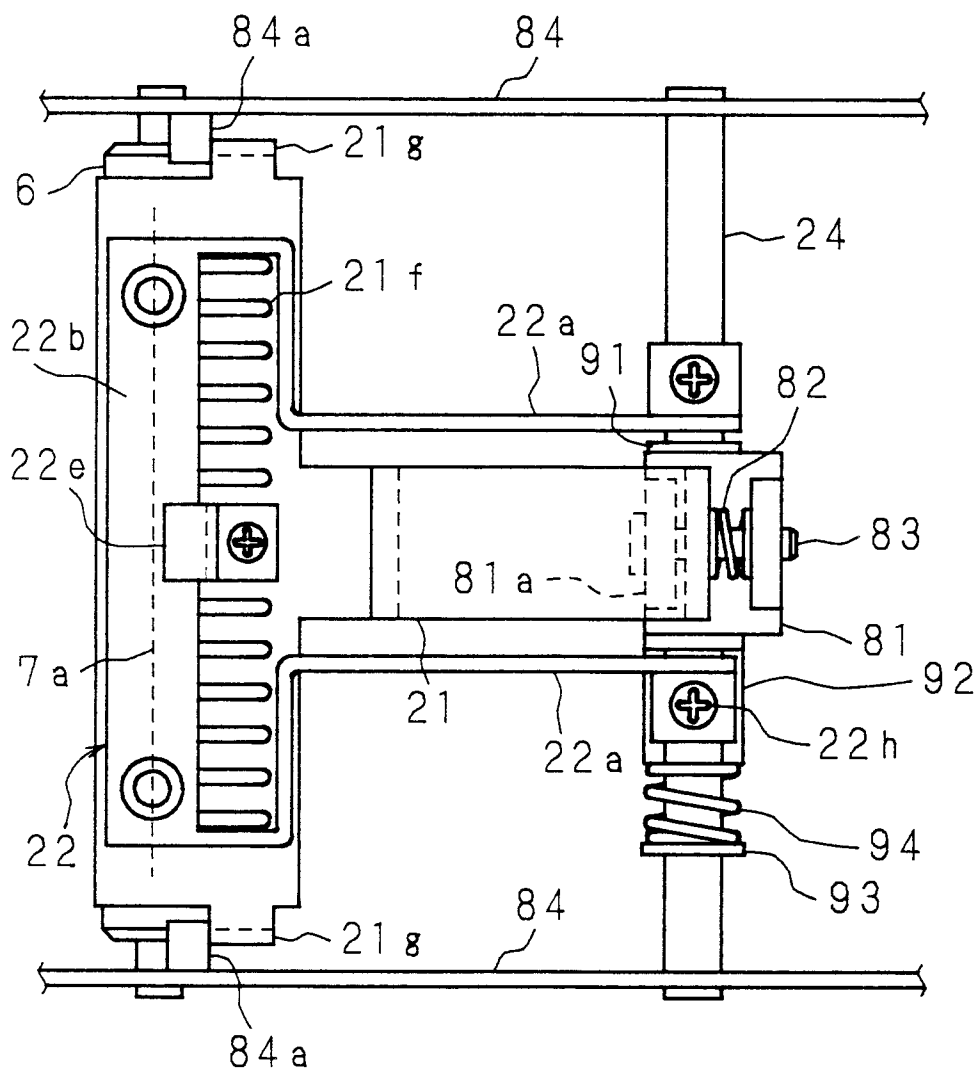


Fig. 59



F i g . 6 0

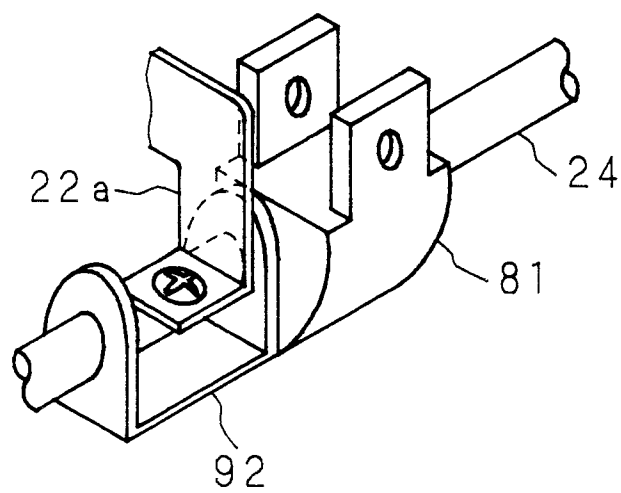


Fig. 61

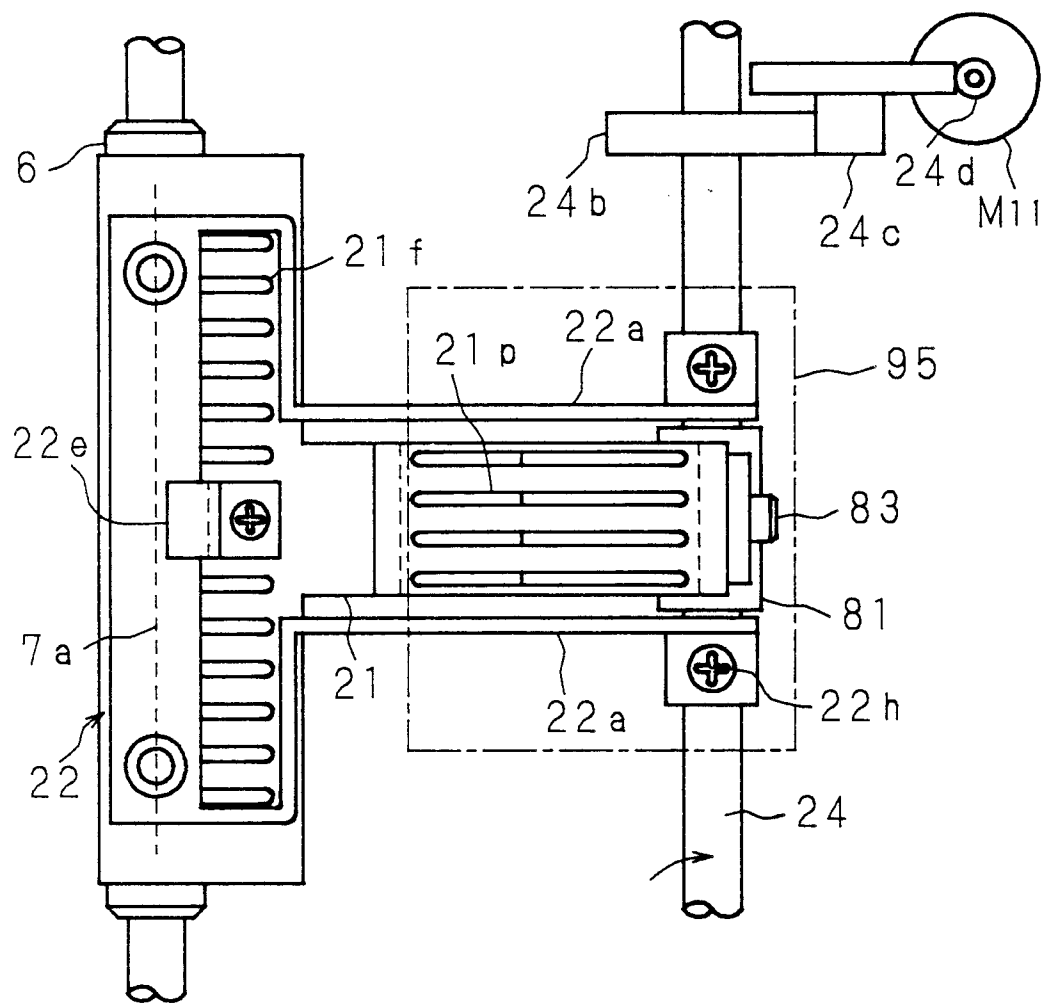


Fig. 62

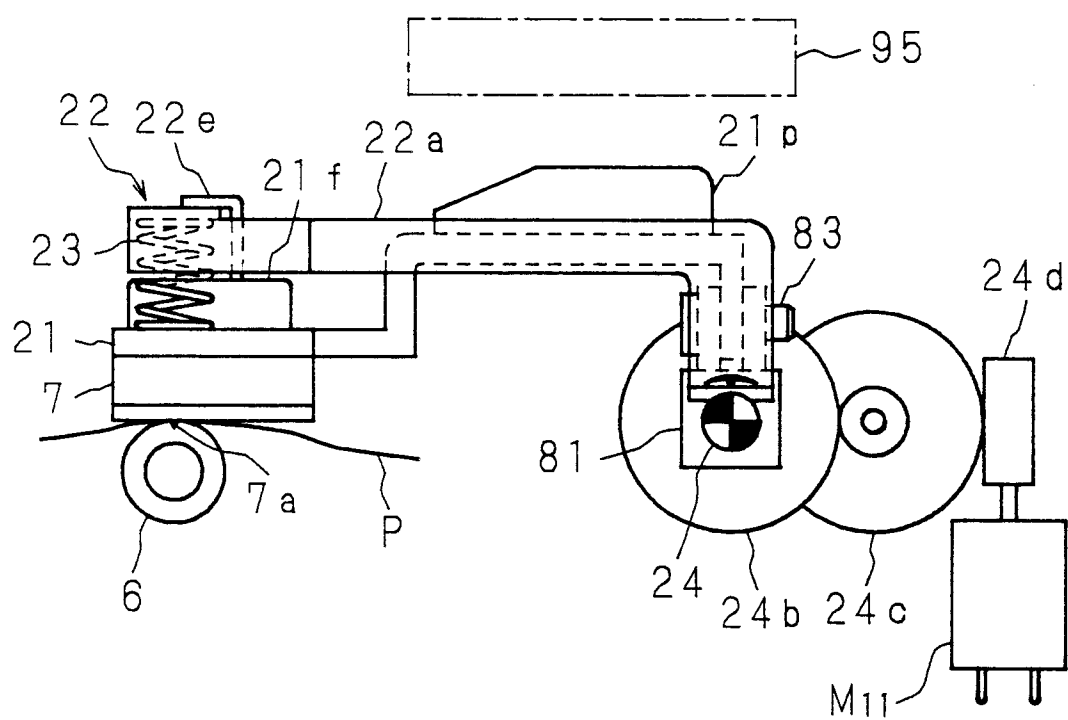


Fig. 63(a)

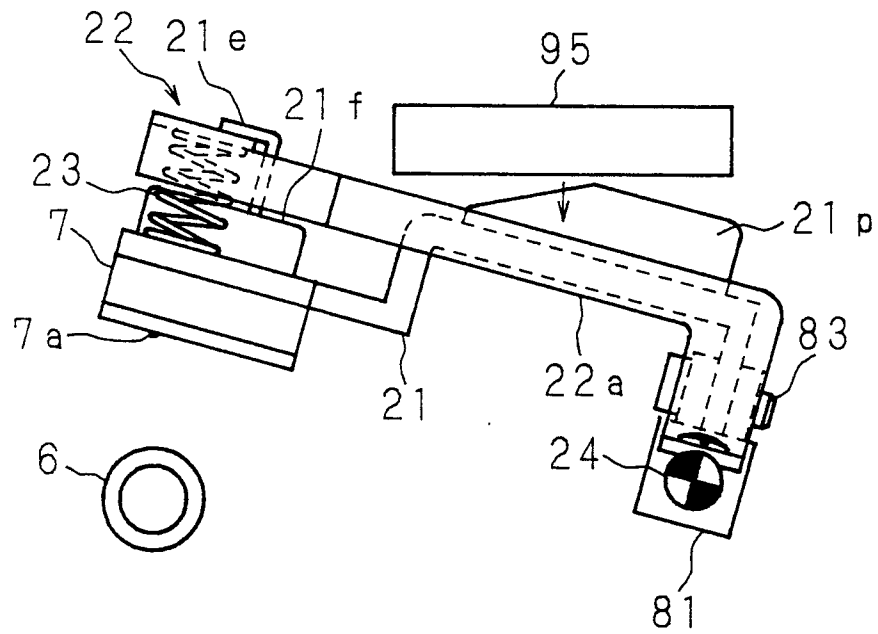


Fig. 63(b)

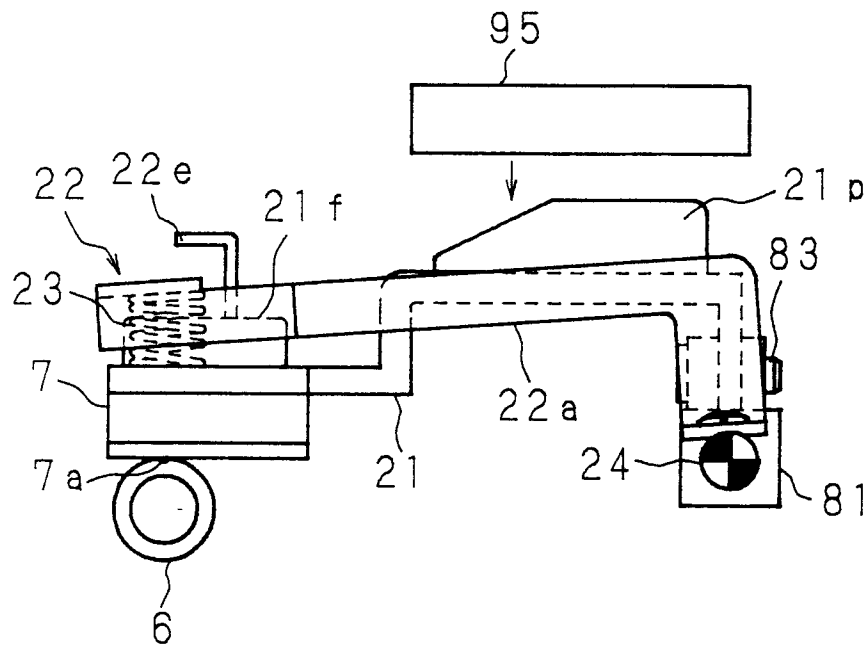


Fig. 64

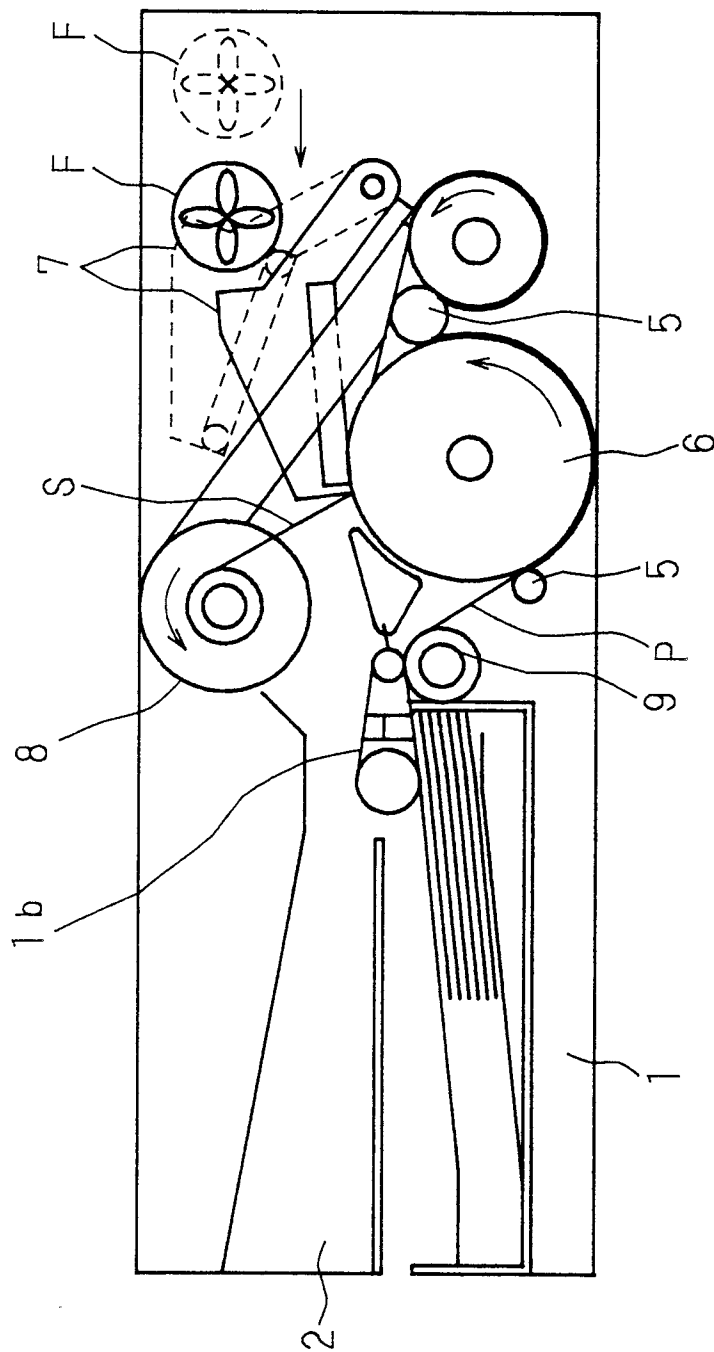


Fig. 65

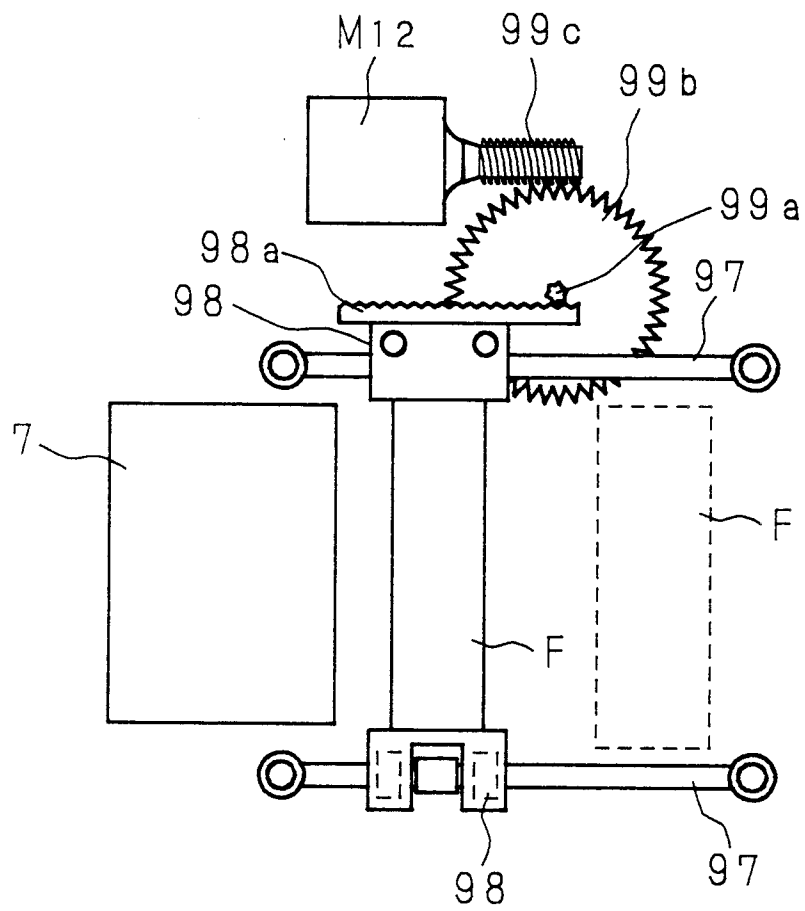


Fig. 66

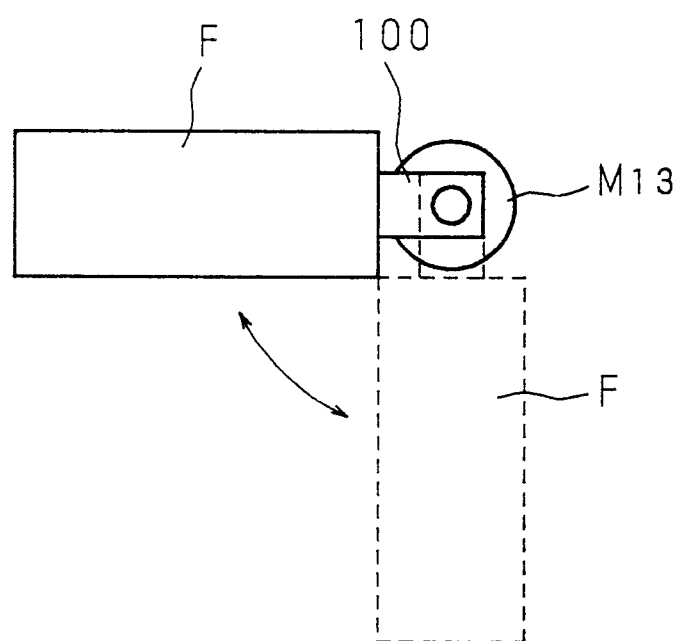


Fig. 67

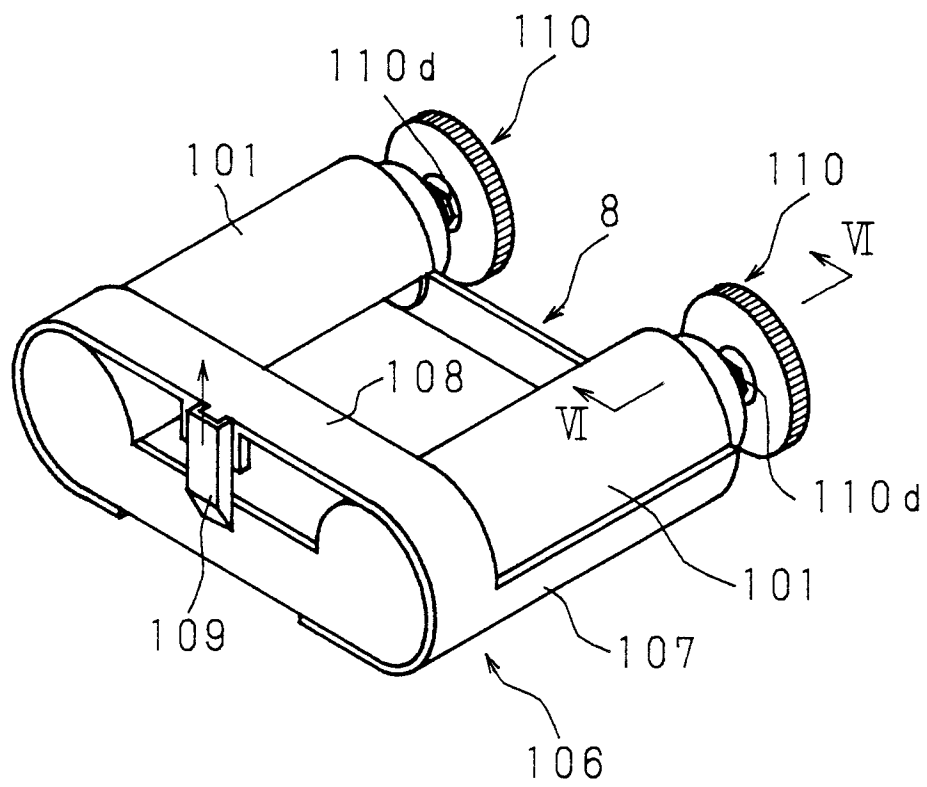


Fig. 68

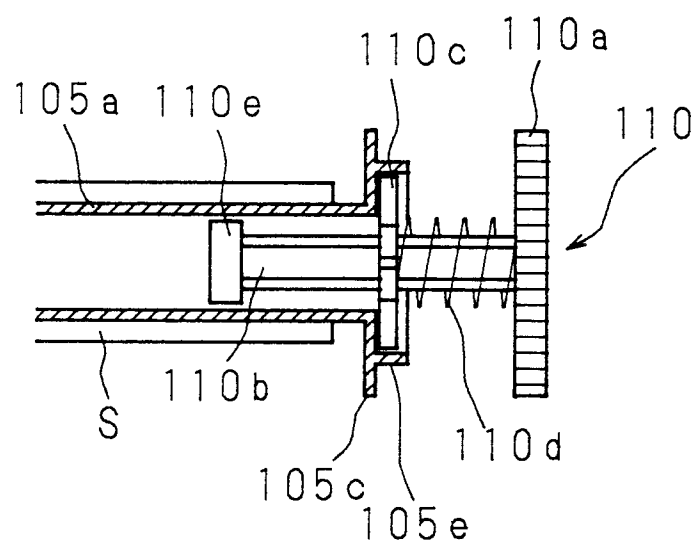


Fig. 69

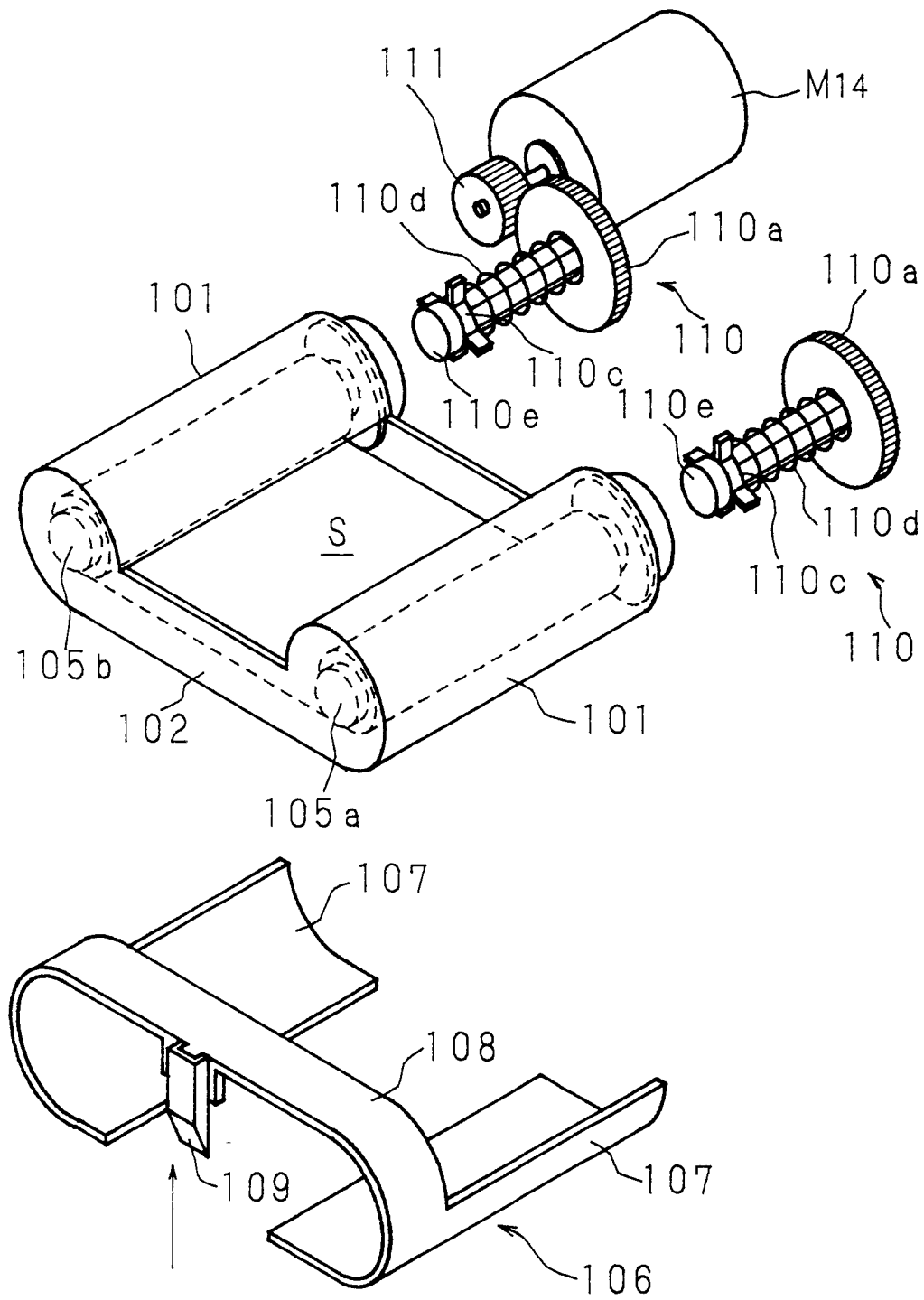


Fig. 70

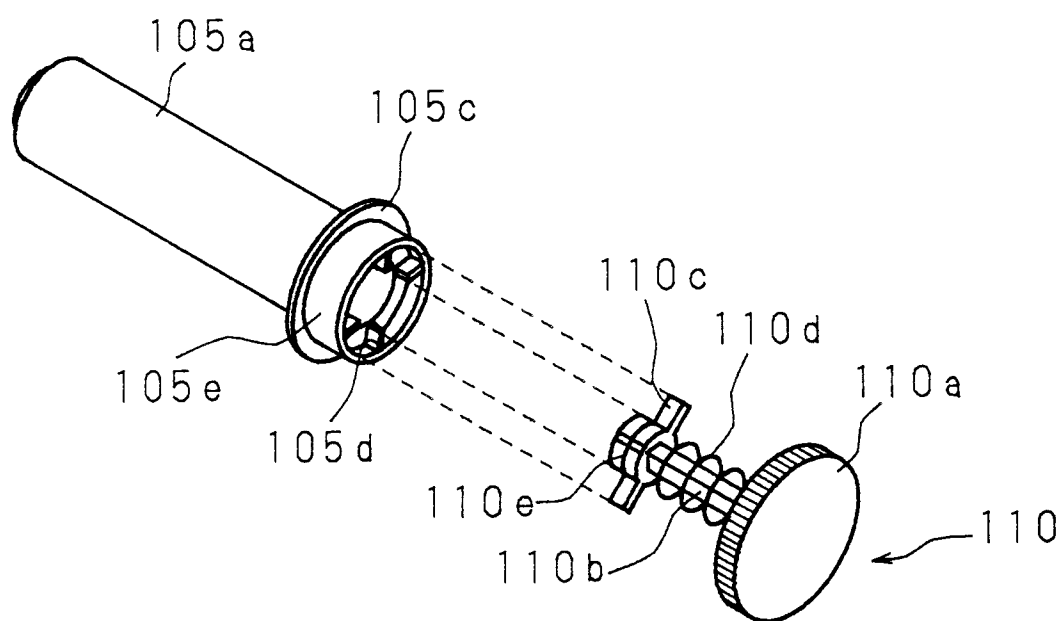
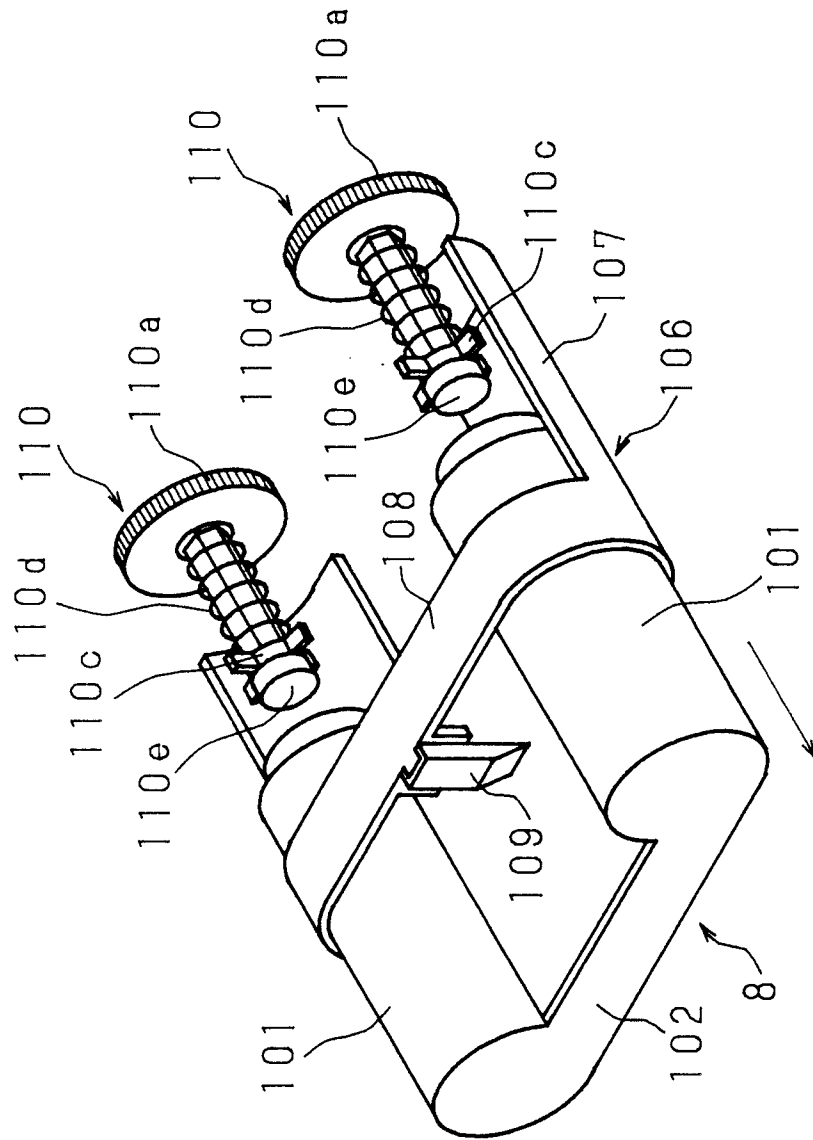


Fig. 71



F i g . 7 2

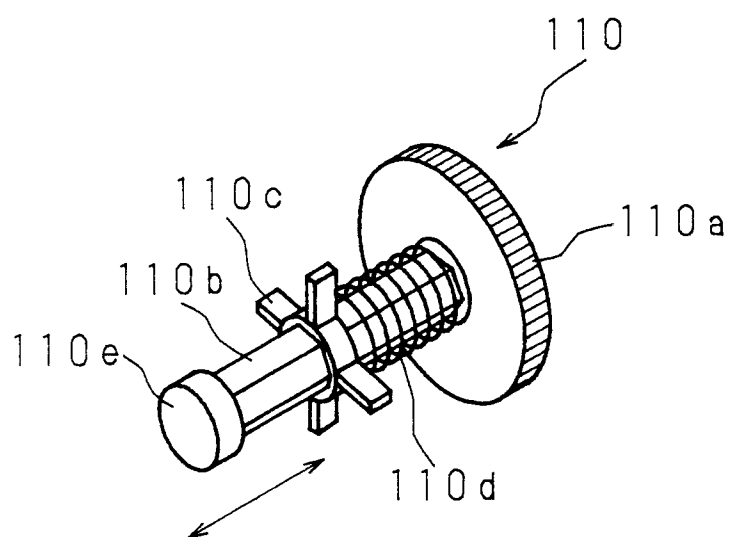
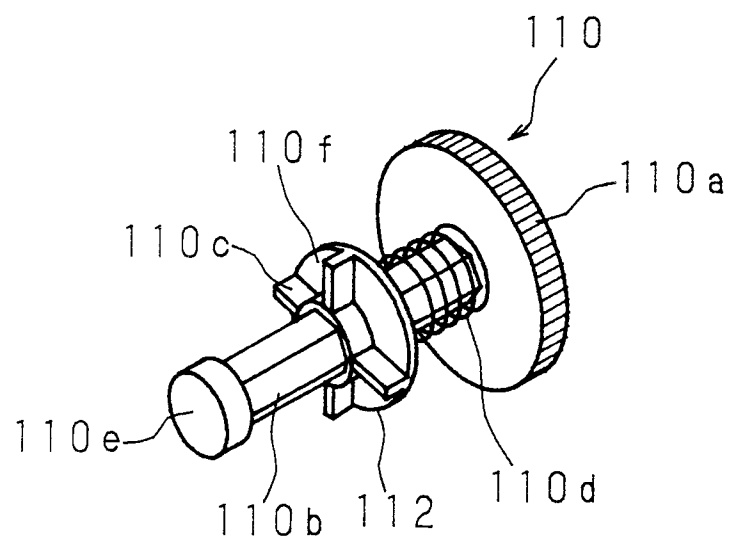


Fig. 73



F i g . 7 4

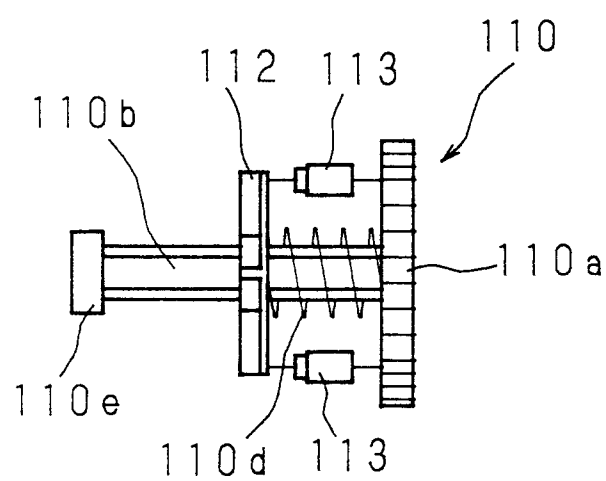


Fig. 75

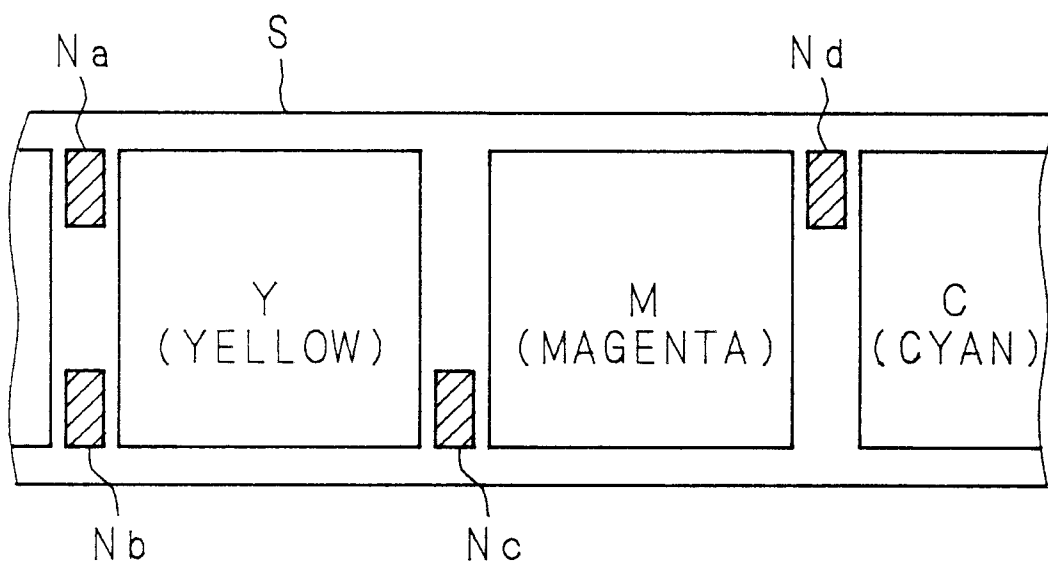


Fig. 76

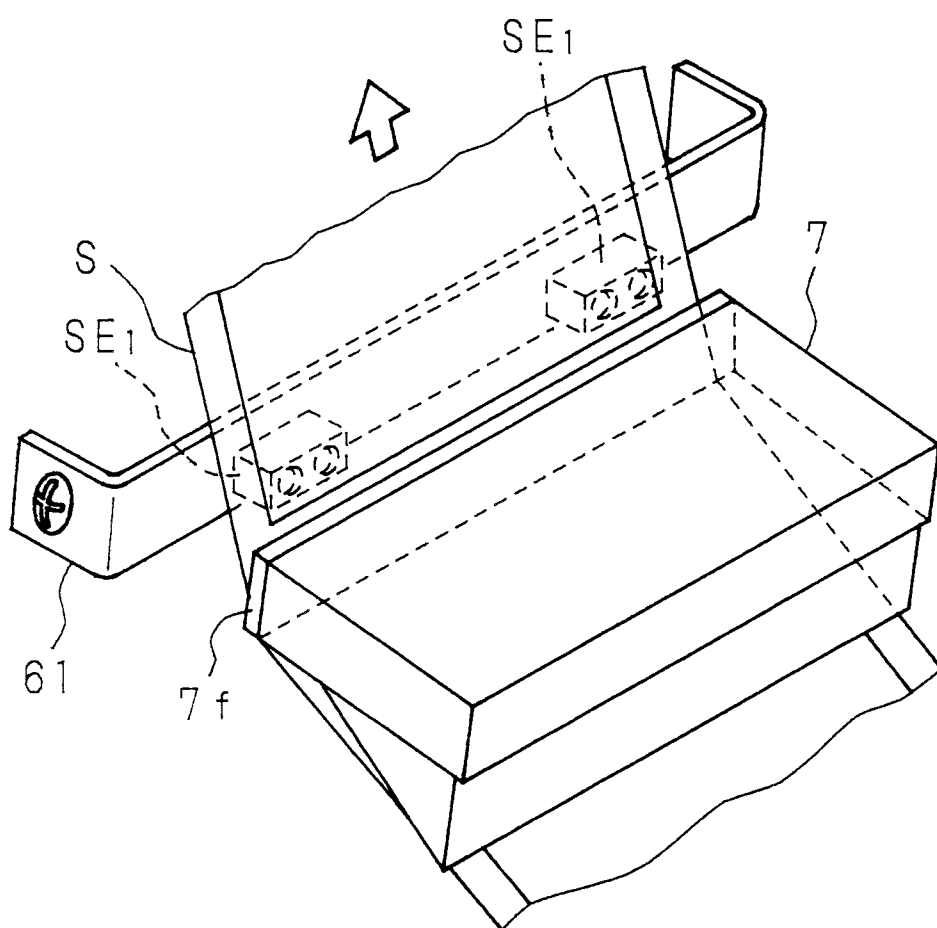


Fig. 77

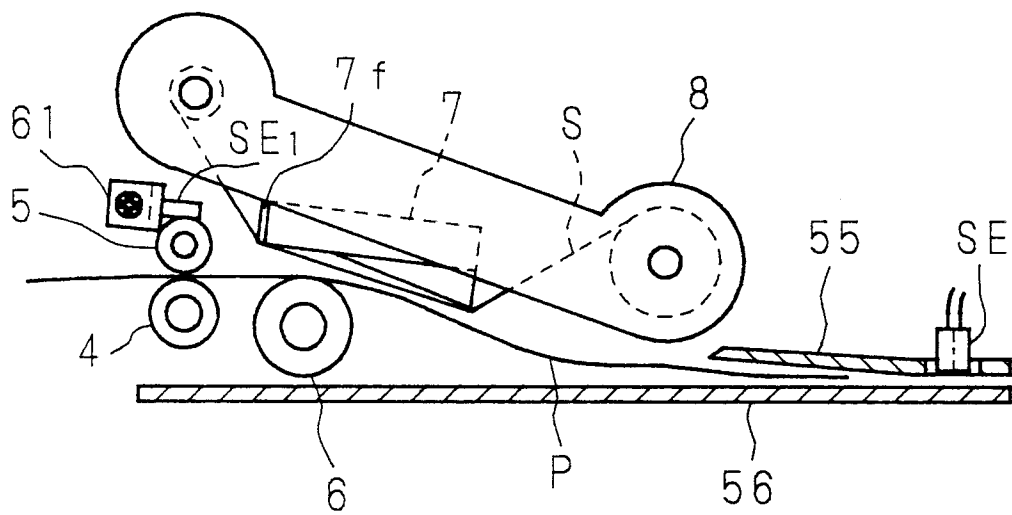


Fig. 78(a)

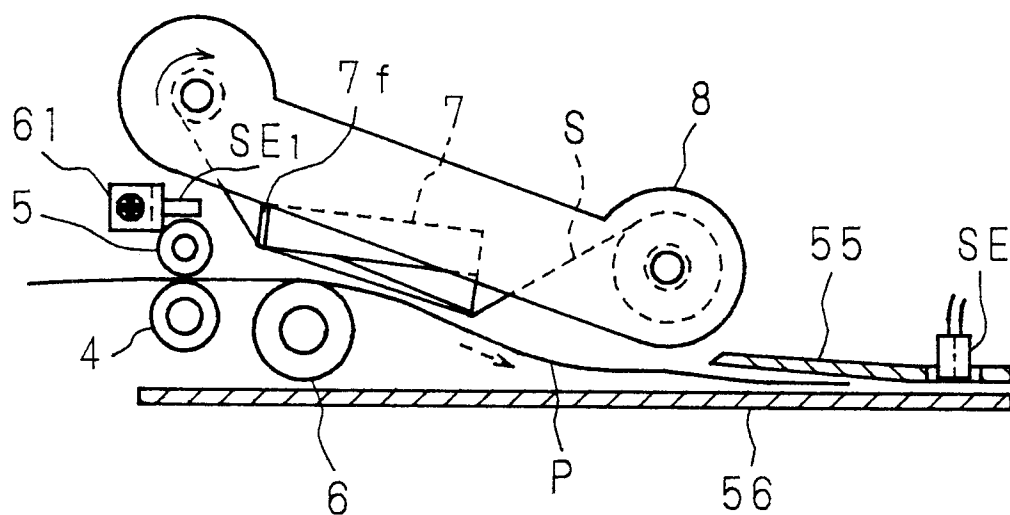


Fig. 78(b)

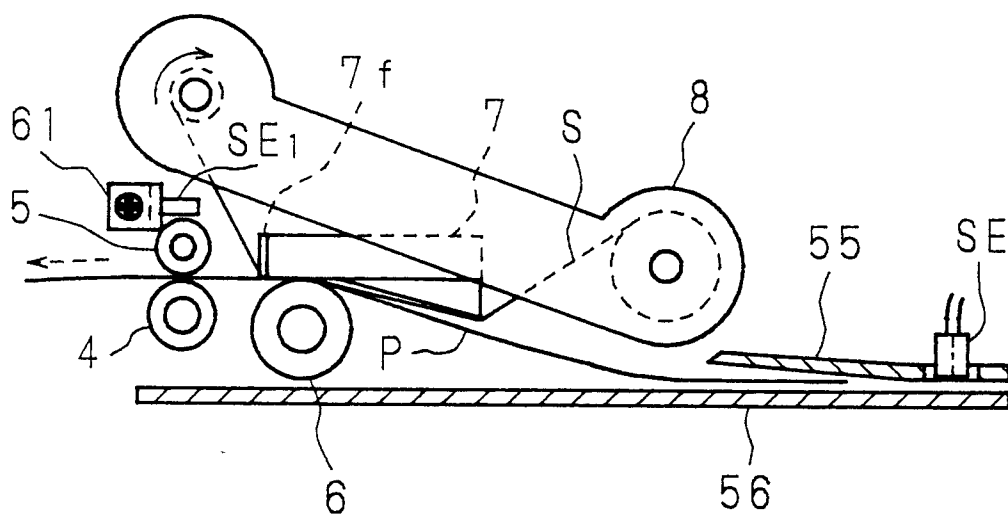
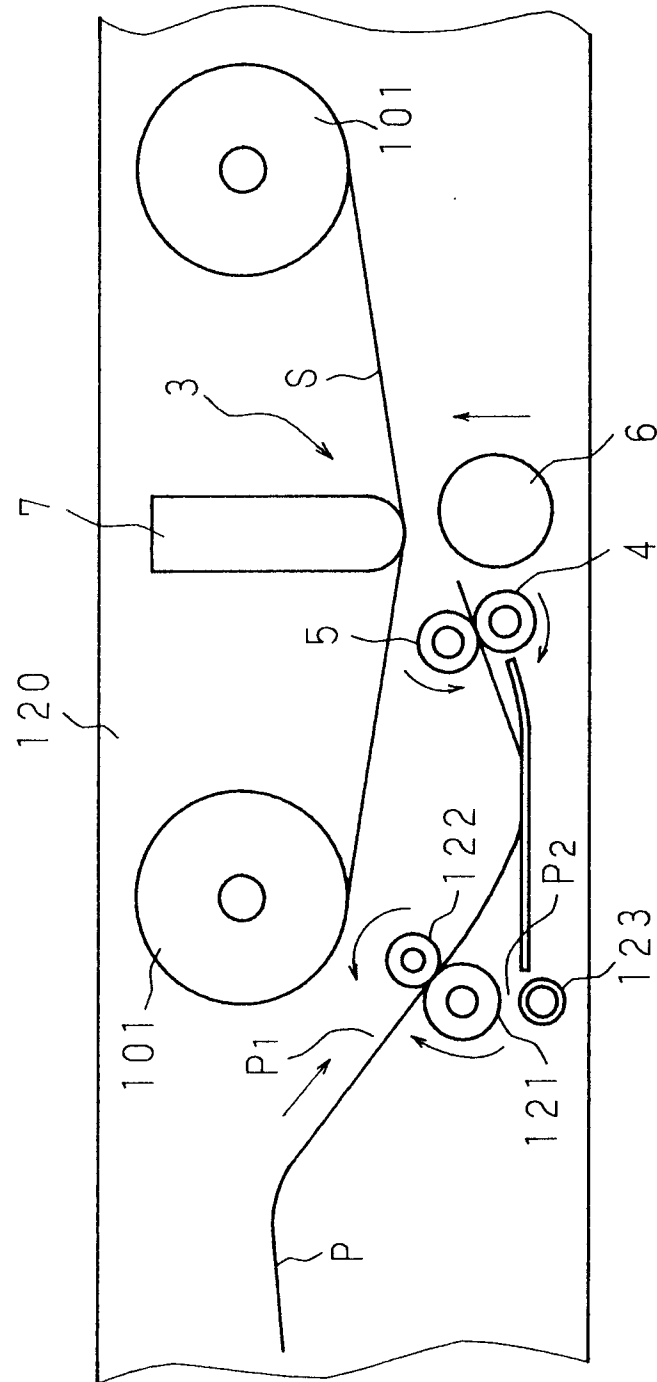








Fig. 79



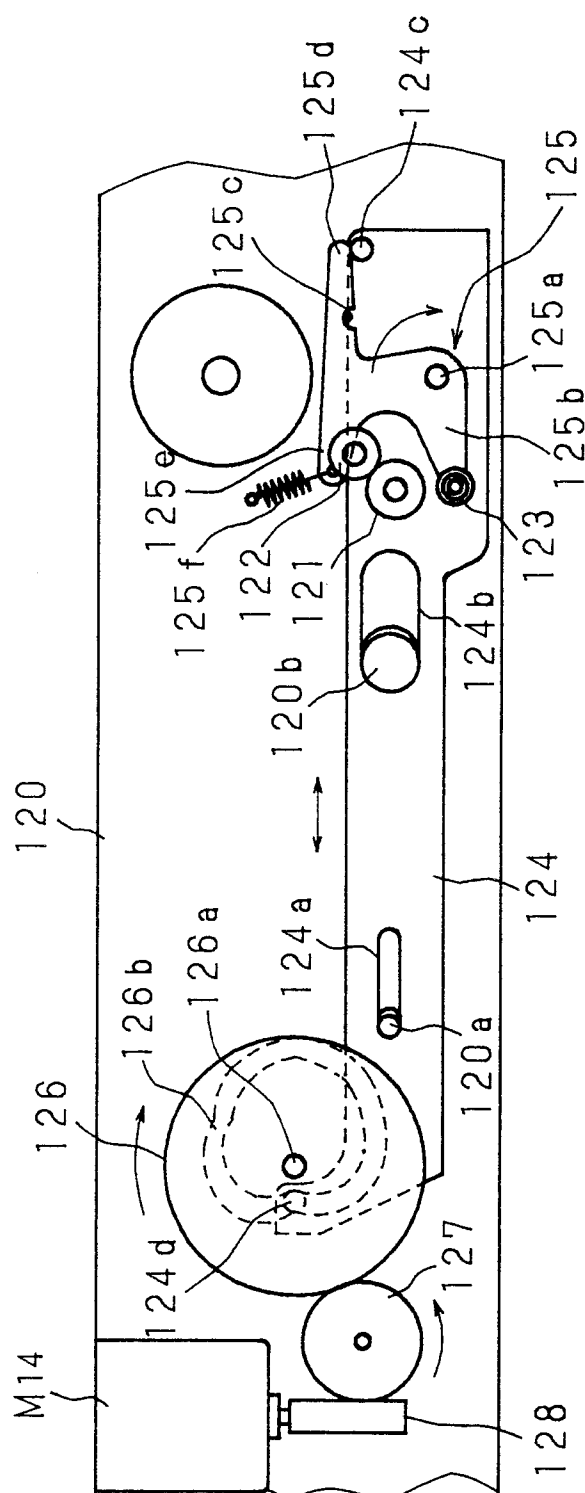


Fig. 81

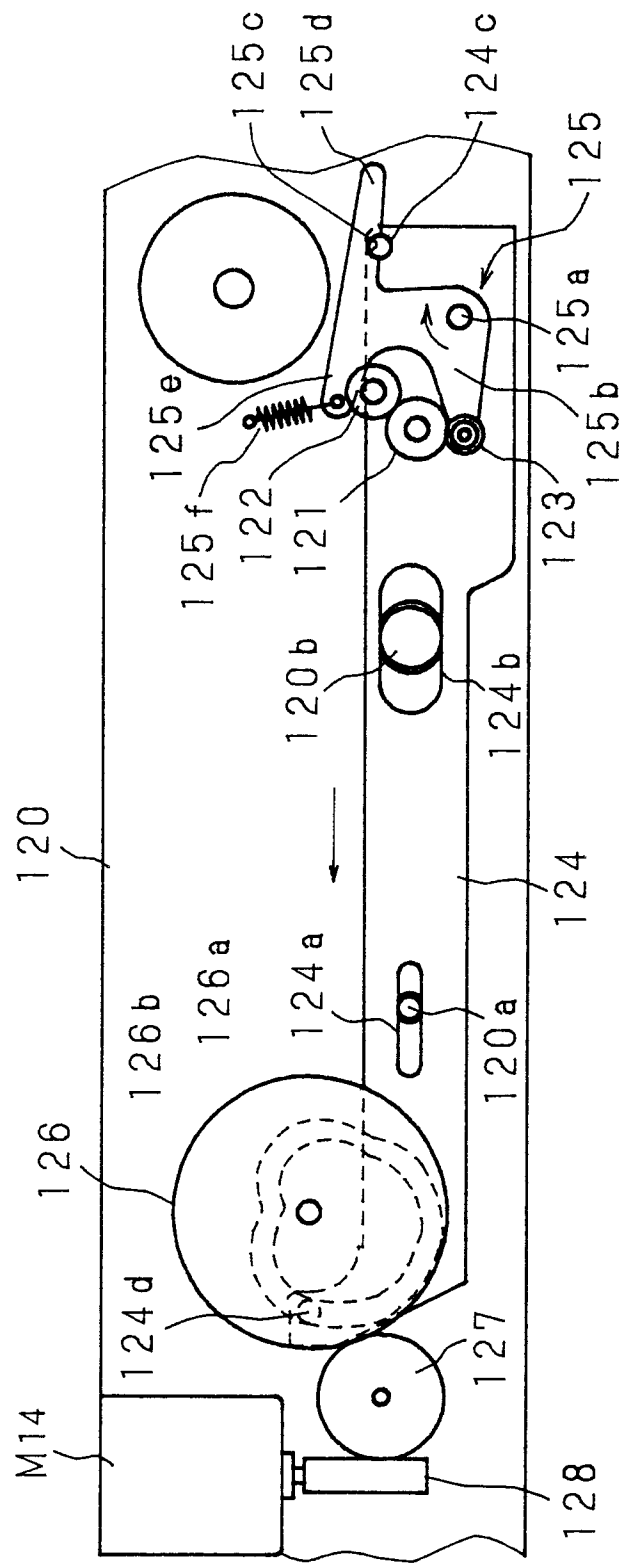
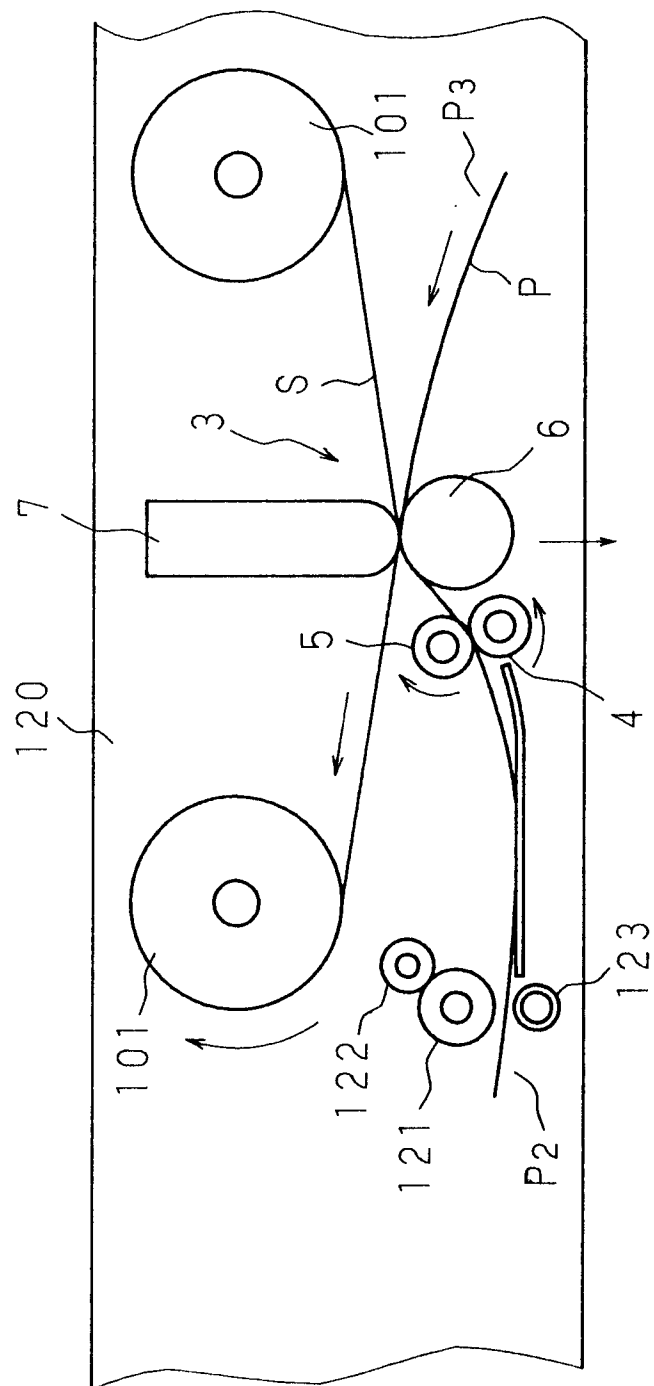


Fig. 82



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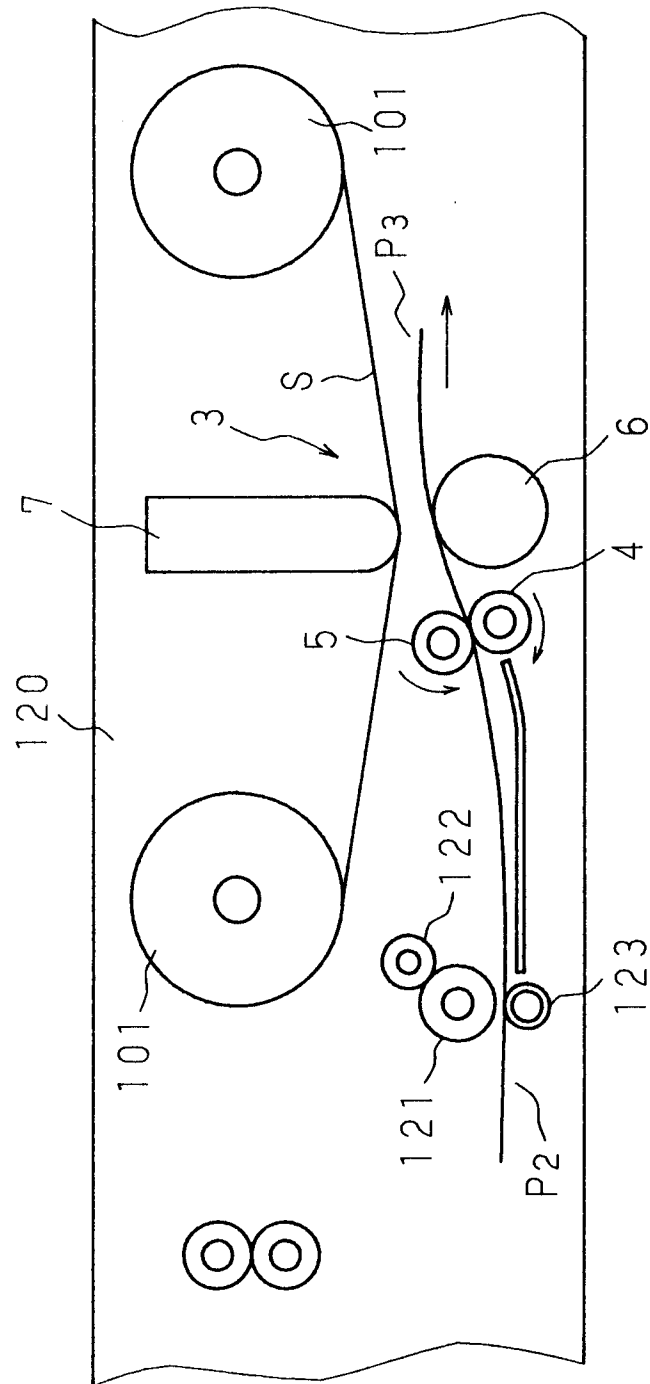


Fig. 84

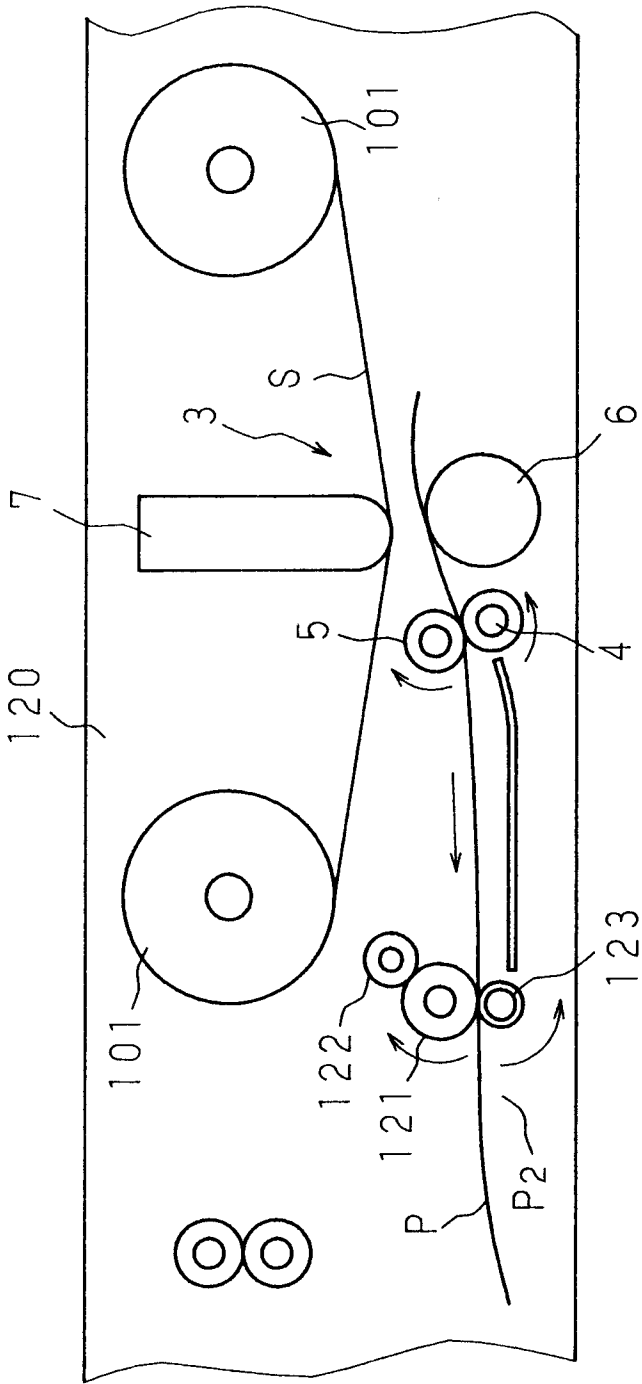


Fig. 85

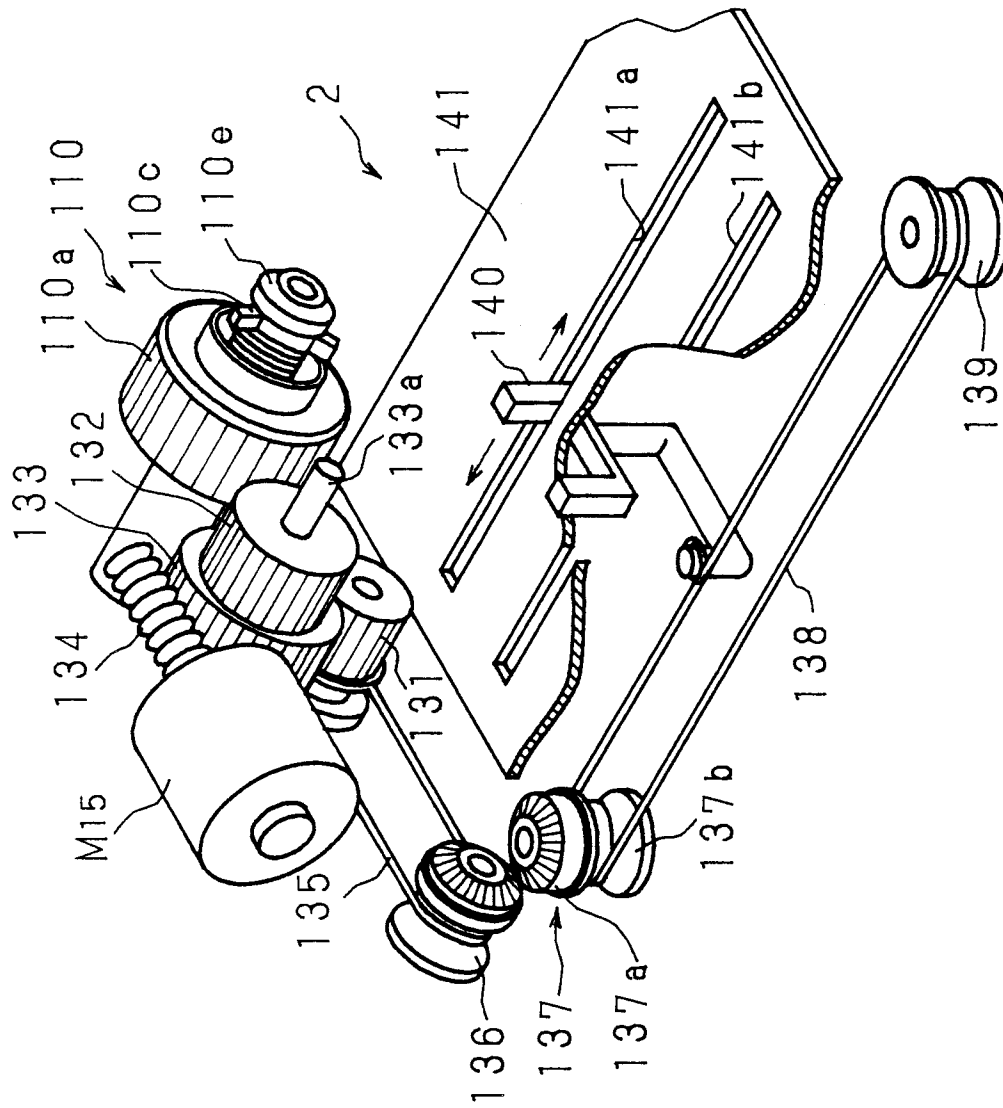


Fig. 86 (a)

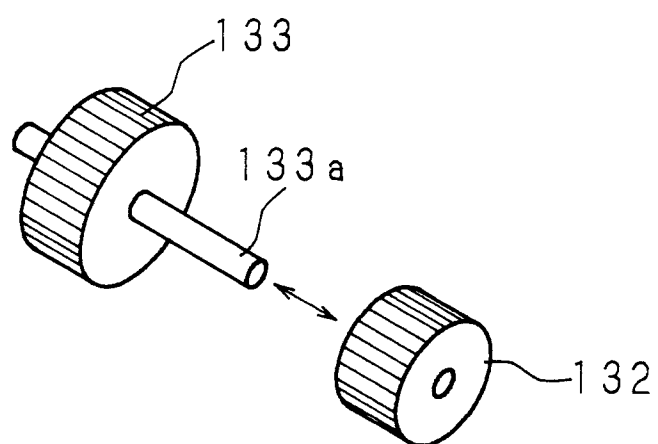


Fig. 86 (b)

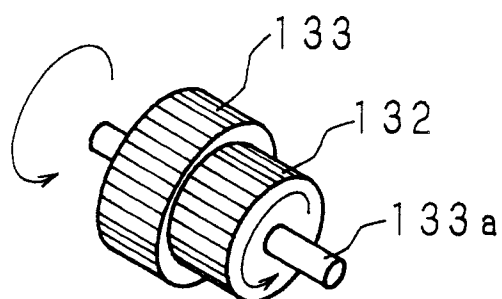
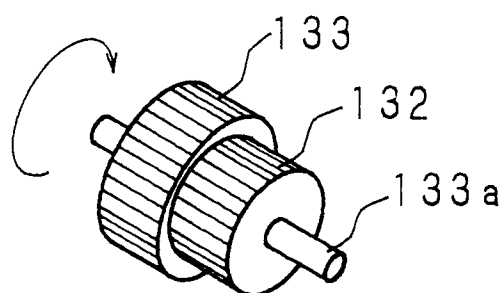
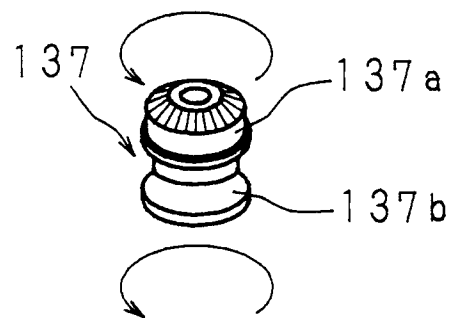


Fig. 86 (c)



F i g . 8 7 (a)



F i g . 8 7 (b)

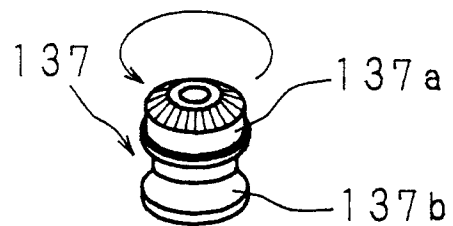


Fig. 88

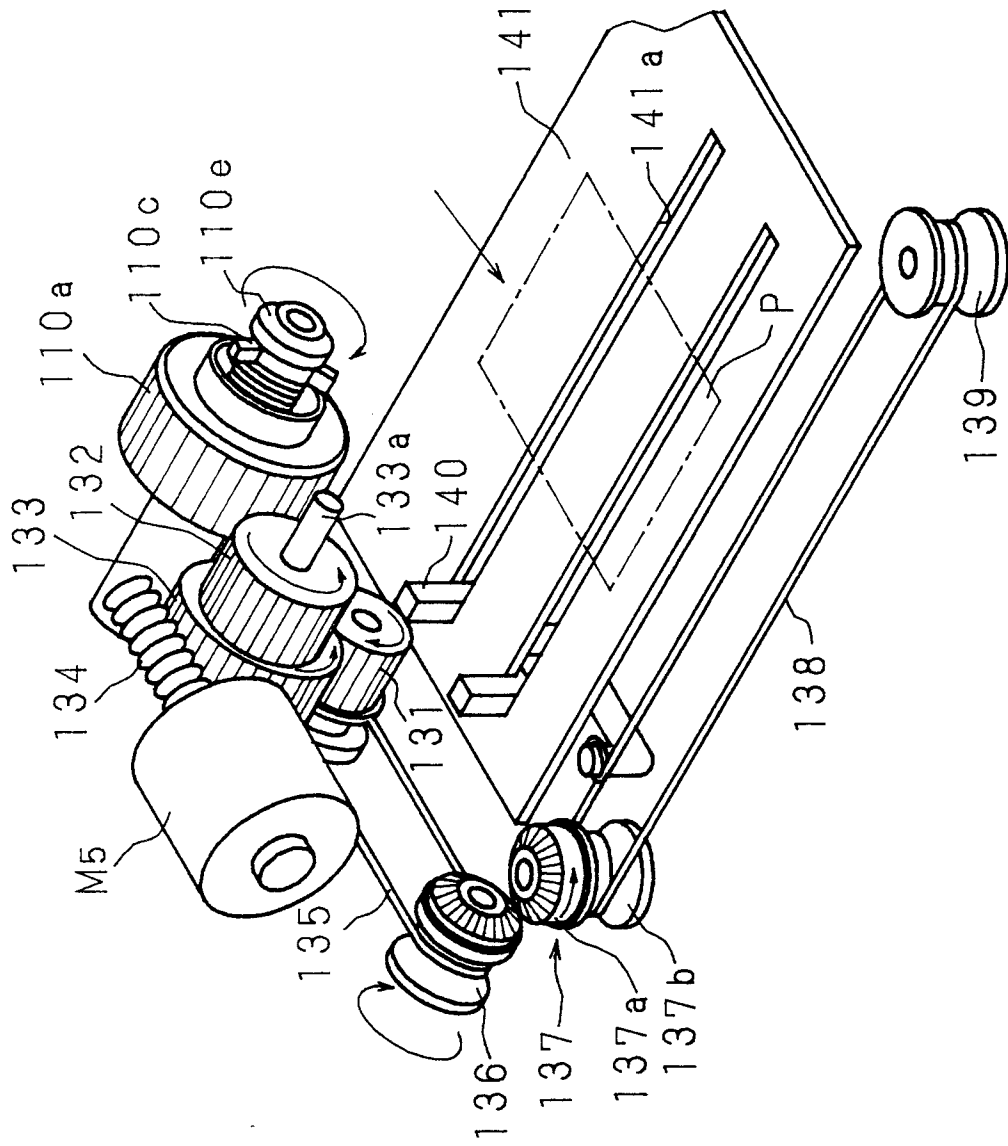


Fig. 89

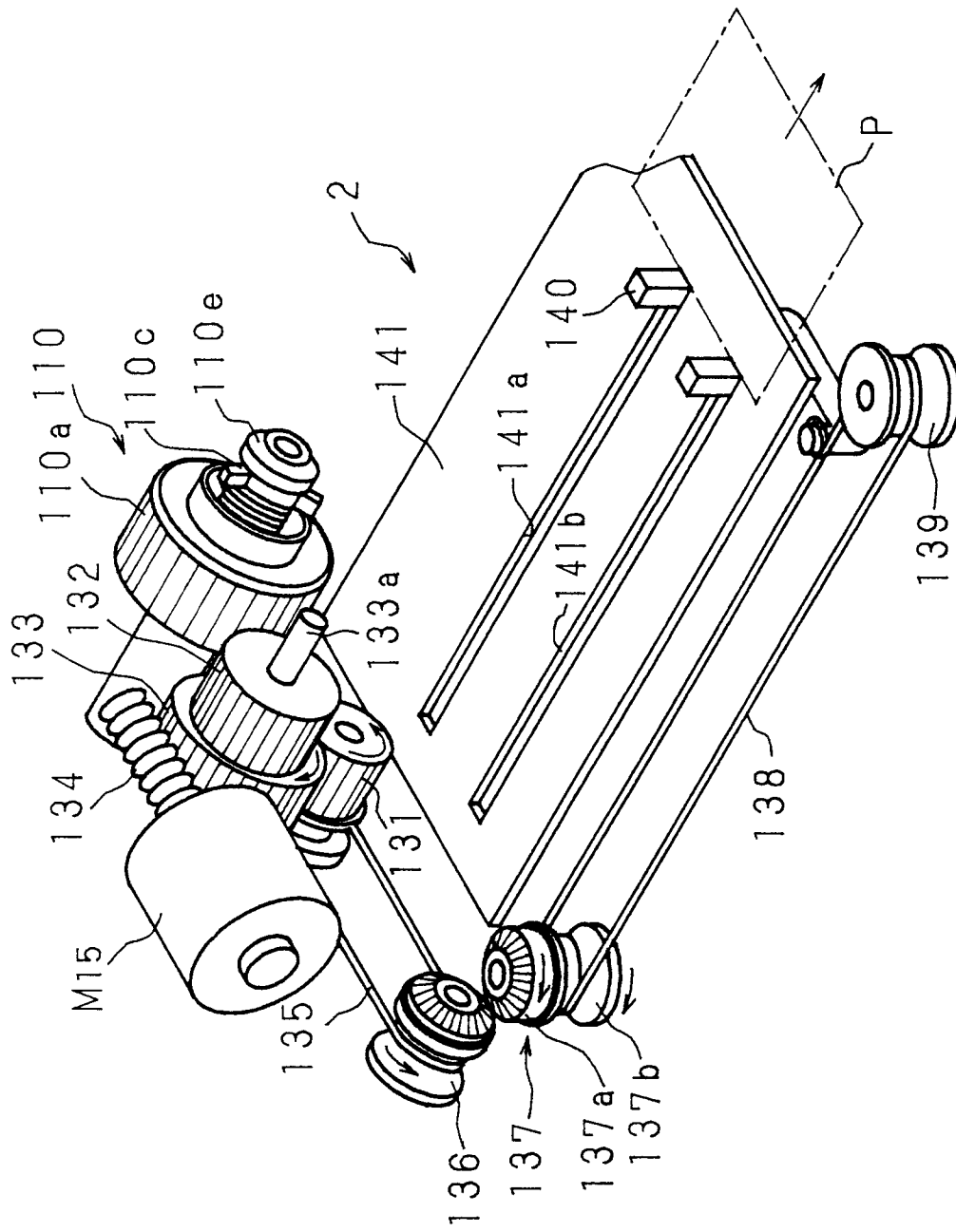


Fig. 90

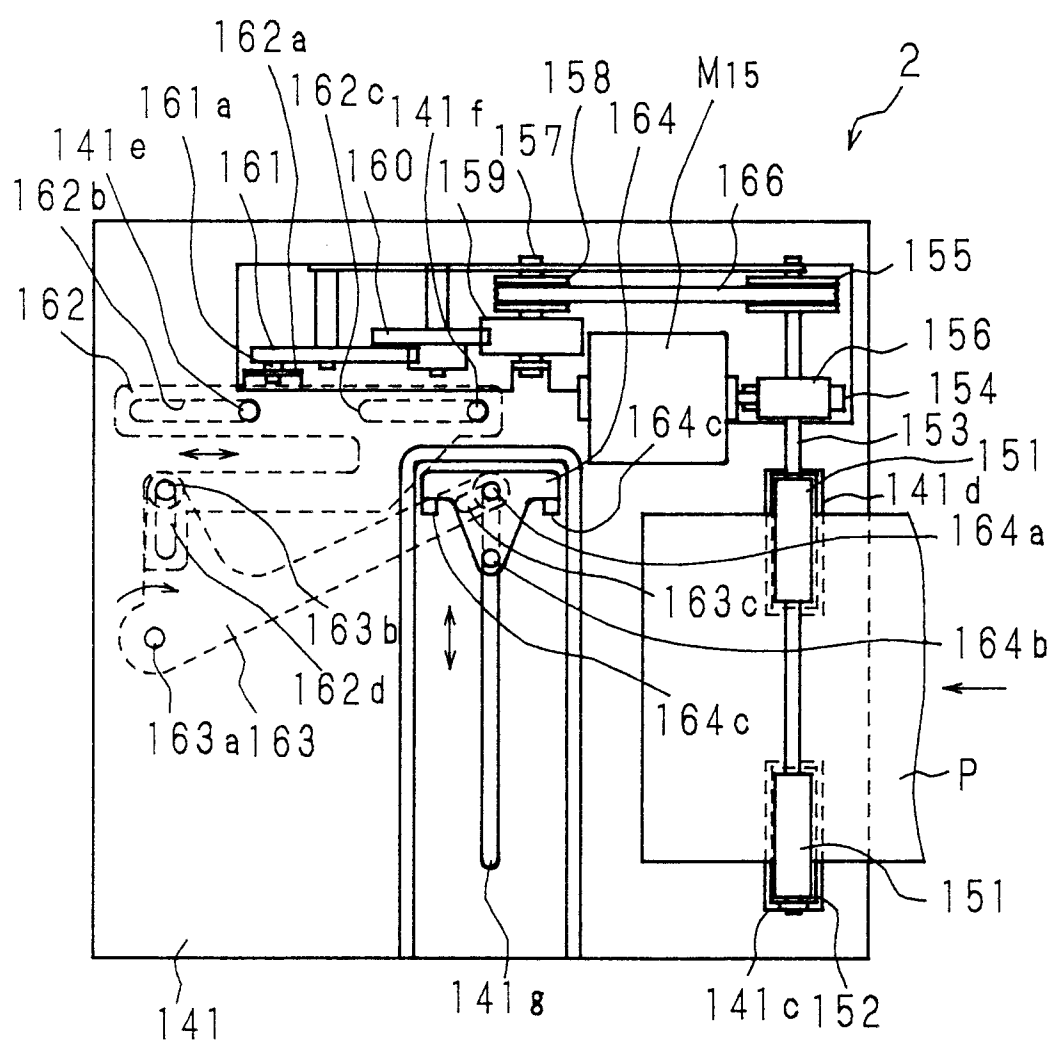


Fig. 91

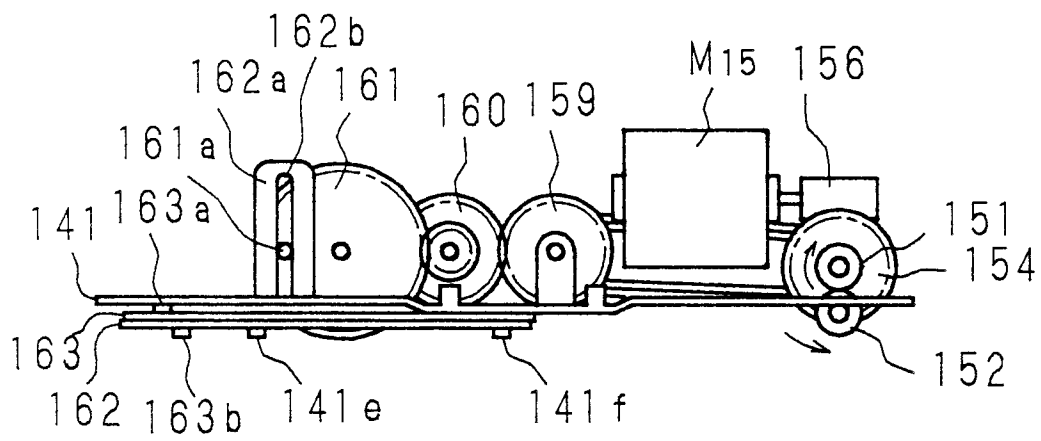


Fig. 93(a)

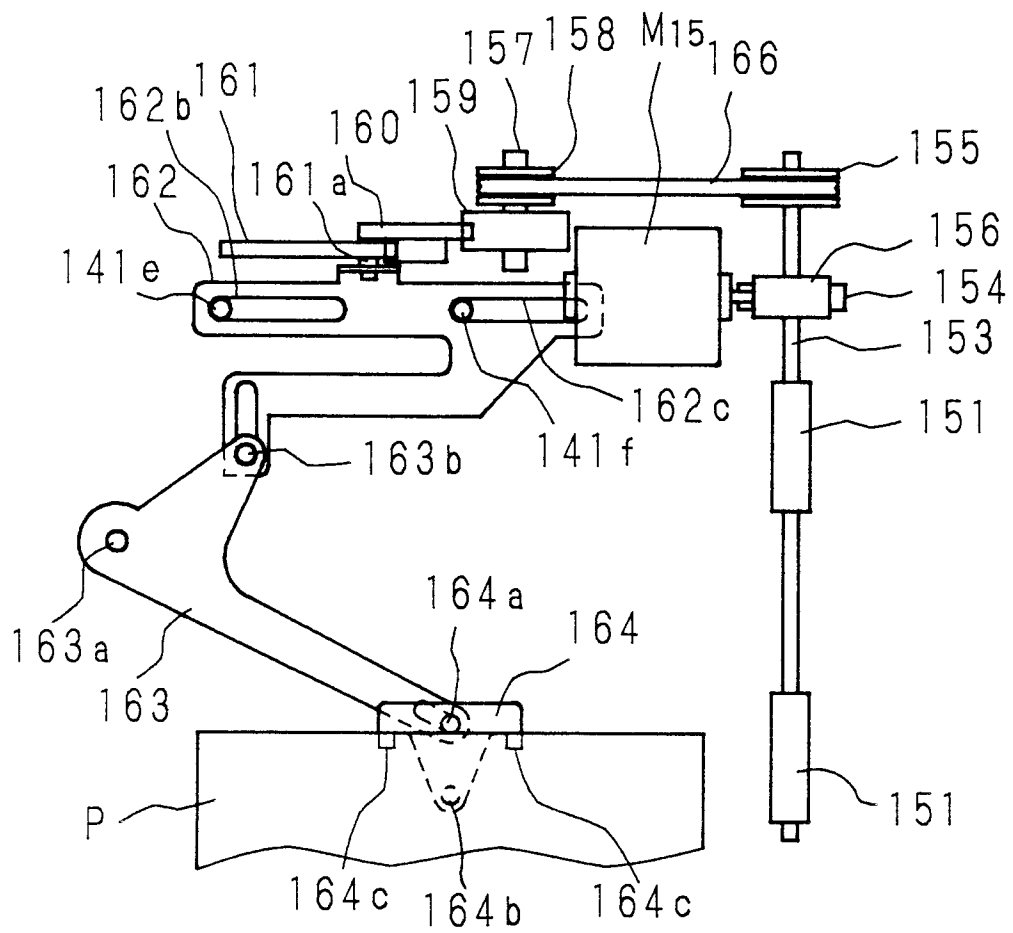


Fig. 93(b)

